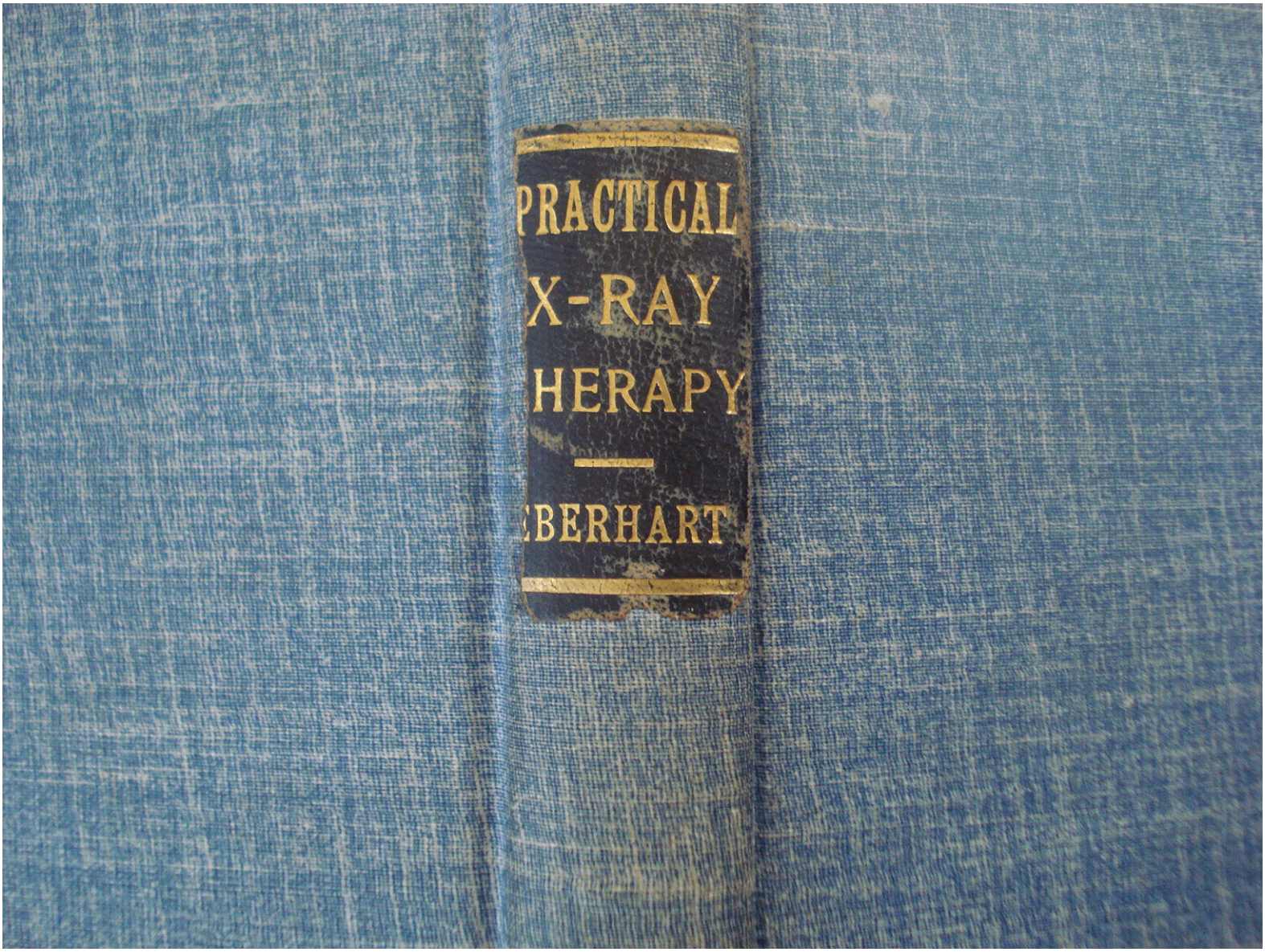

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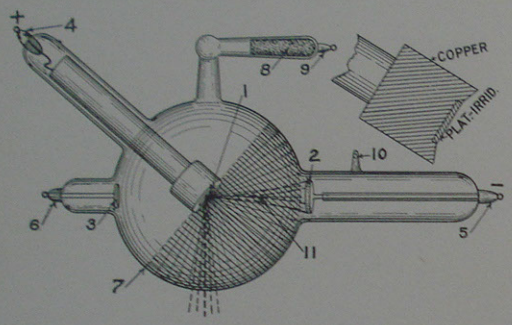

CHART OF AN X-RAY TUBE.

1. Anti-cathode or target. 2. Cathode. 3. Anode. 4. Cap of anti-cathode. For all practical purposes this is looked upon as the positive pole of the tube, and to it is attached the cord from the positive terminal of the coil or static machine. 5. Cap of cathode, or negative pole. The wire from the negative terminal is attached at this point. 6. Cap of anode. 7. Plane of anti-cathode and division between active and passive hemispheres of tube. 8. and 9. Chemical bulb and terminal. 10. Exhaust tip. 11. Cathode stream.

PRACTICAL X-RAY THERAPY

BY

NOBLE M. EBERHART, A.M., M.S., M.D.

Professor and Head of the Department of Electro-therapy, Chicago College of Medicine and Surgery; Professor of High Frequency and Vibration, Illinois School of Electro-therapeutics; Attending Surgeon and Radio-therapist, Frances Willard Hospital. Formerly Attending Physician, Cook County Hospital; Formerly Professor of Electro-physics, Post Graduate Medical School, Chicago. Member Chicago and Illinois State Medical Societies; American Medical Association; Fellow American Academy of Medicine; Fellow American Electro-therapeutic Association; Member of Victoria Institute or Philosophical Society of Great Britain; Editor "Practical Therapeutics"; etc.

SECOND EDITION, REVISED AND ENLARGED

CHICAGO
NEW MEDICINE PUBLISHING CO.,
72 Madison St.

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By Noble M. Eberhart.

PREFACE TO SECOND EDITION.

The author confesses to a feeling of gratification that the first edition of this little work has been so favorably received.

The present edition has been thoroughly revised and much new matter added.

This being intended as a working hand-book covering radio-therapy, all but the briefest reference to radioscopy and radiography is purposely omitted.

A chapter has been added embracing diseases in which the clinical reports are too few to warrant including these diseases in the general list. The technique used by the operators reporting successful results is given as a guide for others.

A glossary also has been added for convenience.

The author has tried to be perfectly fair in referring to unfavorable as well as favorable clinical reports and in trying, where possible, to state the percentage of favorable cases. It is obvious that the personal equation must often cause wide variations in the results obtained by different operators.

The author is desirous of receiving clinical reports that may be made use of in subsequent editions of this work and to that end appends hereto his office address—

72 Madison St., Chicago.

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INTRODUCTION.

The author's intention has been to provide a brief and handy working manual, covering the essentials of the practical application of the Roentgen ray to diseased conditions.

It is especially designed to meet the requirements of the busy practitioner who has installed an X-ray outfit in his office and after having been instructed by the maker of the apparatus in the general management of the same, finds himself confronted by some of the following questions:

What diseases can it be satisfactorly used in? Does it cure them or only give temporary benefit, and if it cures at all, in what percentage of cases? How long and by whom has it been successfully used? Shall a high or low tube be used, and how far away from the patient shall it be placed? How long and how often shall the treatments be given? Shall I trust all to the X-ray or shall I use other treatment in connection?

These and many other practical questions I have tried to answer in this hand-book.

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The subject is treated from a conservative standpoint, which seems to me to be the only way to consider a force which is so powerful and yet so subtle as the X-ray, and capable of doing great harm as well as great good.

It has not been deemed advisable to include definitions of the more common electrical terms, such as volt, ampere, induction, etc., as the reader is presumed either to be familiar with them or to have other works to which he can refer for further information.

No lengthy description of apparatus has been included because that properly belongs to the catalogues of the manufacturers. Sufficient information of a general character is given for the physician to have a general idea of the make-up of apparatus and so that he may intelligently answer questions concerning the same, which will be asked by his patients.

The Roentgen Congress, in Berlin in 1905, adopted a uniform set of technical terms in which Roentgen Ray is used for X-ray, Roentgen therapy for radio-therapy, Roentgenogram for skiagraph, Roentgenoscopy for fluoroscopy, etc.

While approving of a move for a uniform nomenclature, many of these words are long and unwieldy and the author has therefore made frequent use of the older and better known terms.

Under each disease there has been included a brief history of the X-ray treatment of the same; a working technique and a sufficient reference to the literature of the subject to enable a physician interested to secure fuller information than can be given in this hand-book.

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CONTENTS

PART I.

GENERAL PRINCIPLES

CHAPTER I.

Discovery of the X-ray—How Generated—Its Nature—The Ether—How the Ray is Produced—Direct, Indirect and Secondary Rays—Various Theories—Choice of Apparatus—Table of Vibrations—Present Position of Roentgentherapy—Description of Static Machine and Coil—Variable Primaries—Portable Coils—Interrupters—Valves and Rectifiers—The Rheostat—To Tell which Terminal is Positive—Spark Gaps—Time Switch.....19

CHAPTER II.

X-ray Tubes—To Tell a Good or a Bad Tube—How the Tube is Connected—Hemispheres—High and Low Tubes—Focusing—Distance to Place Tube from Surface Treated 65

CHAPTER III.

The Fluoroscope—Substitute for Dark-Room—Fluoroscopic Examinations—Care of Fluoroscope—Regeneration of Fluoroscopic Screens—A Satisfactory Screen—Penetrometers—Methods of Measuring Quantity of X-rays 75

CHAPTER IV.

Skiagraphs—The Plates—A Good Developer—Fundamental Principles—To Obtain a Proper Image—Time of Exposure—Value of the Skiagraph in Dislocations and Fractures—The Skiagraph in Legal Practice—What is Necessary to Make the Plate Competent Testimony.....87

CHAPTER V.

General Action of Ray—Action on Blood—On Glands—Leucotoxin—X-rays and Sterility—Sterilization of Criminals—Effect of Ray on Young Amphibians—Abortion Caused by X-ray and Effect on Pregnancy.....96

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CHAPTER VI.

PAGE

Intensity of Rays—Williams' Table—A Theory of the Absorption of the Ray—Dermatitis the Pathological Manifestation of the Ray—Geyser's Theory—Visible Reaction not Always Necessary—Short Exposures More Easily Controlled—Dermatitis Solely a Question of Dosage—Forms of Dermatitis—Acute Dermatitis—Chronic Dermatitis—Belated Burns—Treatment of Dermatitis—Frequency of Dermatitis—Does the X-ray Produce Cancer—Blondes More Susceptible to the Ray—Factors Governing X-ray Exposures—Roentgen Ray vs. Surgery — Post-Operative Radiation — Production of Fluorescence in the Human Body.....105

CHAPTER VII.

Protective Measures—Protection of Patient—Shields, Masks, etc.—Protection of Operator—Methods of Various Operators—General Considerations.....123

CHAPTER VIII.

Importance of Personal Equation in Electro-therapy—Schiff & Freund's Technique—Kienbock's Technique—Burdick's Technique — Pusey's Technique — Author's Technique—Management of Apparatus.....145

CHAPTER IX.

Classification of Diseases Suitable for Treatment.....155

PART II.

PRACTICAL TECHNIQUE

CHAPTER I.

Technique in Treatment of Acne Vulgaris—Acne Rosacea—Actinomycosis — Alopecia Areata — Blastomycosis—Carcinoma—Eczema—Epithelioma and Rodent Ulcer—Favus and Tinea Tonsurans—Goiter—Hyperidrosis—Hypertrichosis—Keloid—Keratosis—Leprosy—Leukemia and Pseudo-Leukemia—Lipoma—Lupus Vulgaris—My-

PAGE

cosis Fungoides—Naevus—Onychitis—Pain—Pruritus—Psoriasis—Sarcoma—Sycosis — Trachoma—Tuberculosis—Tuberculosis of Lungs—of Glands—of Kidney—of Peritoneum—of Testicle—of Joints—of Tendon Sheaths—of Long and Flat Bones—of Larynx—Venereal Warts.161

CHAPTER II.

Clinical Reports and Technique in Arthritis Deformans—Carbuncle—Chronic Bronchial Affections—Erythema Multiforme—Hydrocephalus and Rachitis—Lichen Planus—Neuralgia—Neuritis—Paget's Disease—Pernicious Anemia—Enlarged Prostate—Gynecological Affections—Stiff Joints—Syphilitic Lesions—Syringomyelia—Varicose Veins—Miscellaneous Diseases—Malignant Bladder Disease—Multiple Papillomata of Larynx.....239

GLOSSARY 252

INDEX 284

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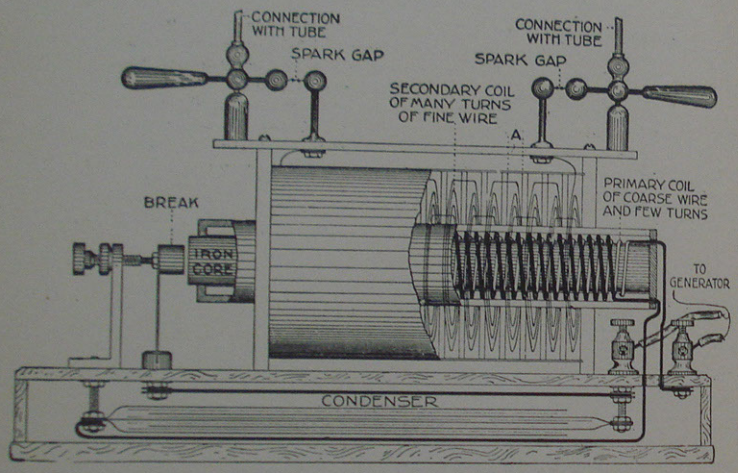

Diagram showing the construction of an induction coil. (Rollins.)

Part I.

GENERAL PRINCIPLES

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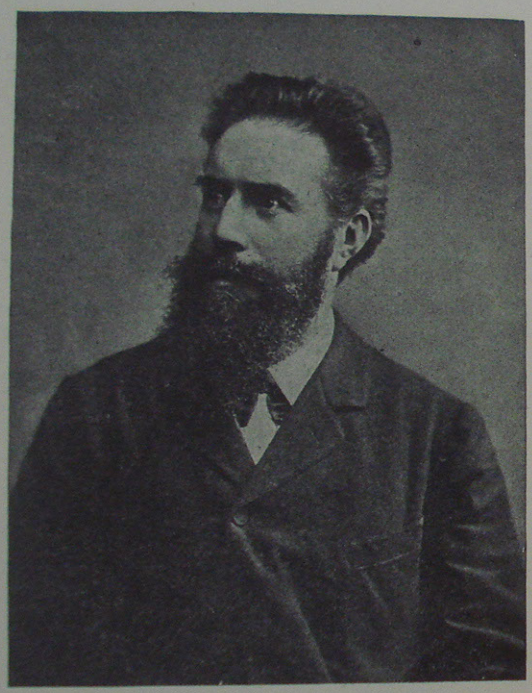

Prof. Wm. Roentgen, Discoverer of the X-ray.

CHAPTER I.

Discovery of the X-ray—How Generated—Its Nature—The Ether—How the Ray is Produced—Direct, Indirect and Secondary Rays—Various Theories—Choice of Apparatus—Table of Vibrations—Present Position of Roentgen-therapy—Description of Coil—Variable Primaries—Portable Coils—Interrupters—Valves and Rectifiers—The Rheostat—To Tell Which Terminal Is Positive—Spark Gaps—Time Switch.

Historical.—The X-ray was discovered by Prof. Wm. Roentgen of the Royal University of Würzburg and officially communicated to the scientific world in December, 1895.

Roentgen in developing some photographic plates found shadows of foreign bodies and evidence of clouding or fogging of the plates. Shortly after, when working with a Crooke's tube, enclosed in a cardboard box, he noticed that some crystals of barium-platinum-cyanide glowed and fluoresced when the tube was in action. This revealed to him the presence of an unknown ray, which he designated after the manner of algebraic formulas, as the X-ray.

Generation of the X-ray.—The X-ray is produced with a Crookes' tube excited by means of an induction coil, static machine, Tesla coil, or closed transformer. The induction coil and the static machine are the forms generally used.

Crookes' tubes, named after their originator, Sir

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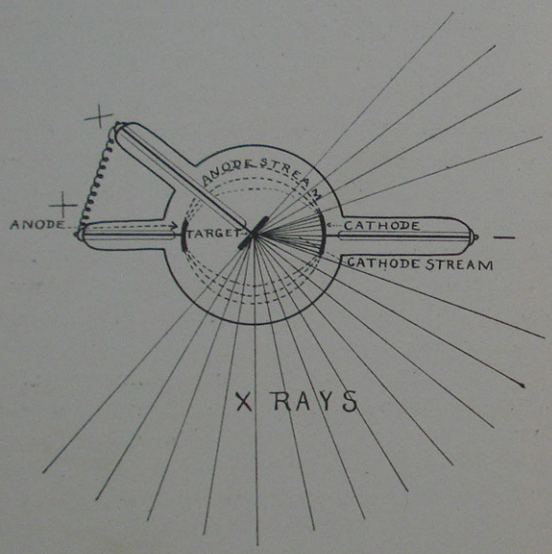

Illustrating the Generation of the X-ray.

Wm. Crookes, have been in use since 1879. They were at first long and pear-shaped.

In 1893 Lenard, while experimenting with the cathode rays, emanating from Crookes' tubes, found new forms of radiations of light, but could not isolate them, and it remained for Roentgen to do this in 1895.

Nature of the Ray.—It is generally looked upon as a vibration of the ether, but it cannot be reflected* or refracted as can ordinary light and moves forward always in straight lines, passing through objects hitherto known as opaque.

The Ether.—The ether is a medium supposed to fill all space, not only between bodies, but also between the atoms or molecules making up various substances. It is 1,000,000 times less dense than water and transmits by its vibrations or waves, light, electricity, Roentgen rays, etc.

How the Ray is Produced.—The X-ray tube is, comparatively speaking, a vacuum, nearly all of the air having been exhausted by means of mercury pumps. The rays from the negative end of the tube, called the cathode stream, are converged by the form of this pole so that they strike on the metal disk in the center of the tube, called the target or anti-

*Carmichael claims to have succeeded in reflecting the rays by means of steel mirrors. The apparently reflected rays may be secondary rays, only, as the latter are given off when the rays strike dense material particles.

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cathode. At this point the X-rays are given off, passing in all directions anterior to the face of the target.

Direct, Indirect and Secondary Rays.*—The rays produced at the target are called the direct rays. Some parts of the cathode stream may not reach the target but may be carried along by the direct rays so that they impinge on the wall of the tube, where they are converted into X-rays. These are indirect rays. Where either the direct or indirect rays strike solid particles, secondary rays are given off. The indirect and secondary rays are responsible for the blurring frequently occurring in skiagraphs.

Theories Concerning the X-Ray.—Roentgen considered the X-rays to be longitudinal vibrations of, or in, the ether.

The more generally accepted view is that the cathode ray is converted by its impingement upon the target into a new ray of different wave length and different characteristics, which we call the X-ray.

Still another commonly accepted theory is that the particles of gas within the tube carry the cathode charge.

A theory advanced by Mayer† is that the cathode rays "consist of moving material particles, the electrons, which have a considerable electric charge. If such a cathode ray particle flying with great velocity, strikes a solid substance, e. g., the anti-cathode or the glass wall of the Roentgen tube, an ether impulse of extremely short duration is caused. Such an impulse consists of one single wave, i. e., the ether particle performs only one vibration, its velocity is changed only once in a very rapid manner. The ether particle is strongly diverted from its equilibrium, and returns to its former position without periodically swinging around its point of equilibrium. The emitted wave in this case might lack the negative amplitudes, it takes the character of a momentary impulse of the ether.

"Light waves, on the other hand, which present themselves as waves of electro-magnetic energy, consist of a long series of coherent waves. Here the ether particles when their balance is disturbed perform a great number of vibrations before they return to their own small swinging amplitudes."

There can be little doubt in the light of past experience that the electrons represent moving material particles of a positive polarity torn loose from the anode or anti-cathode, whichever forms the positive pole, and carried along at a high velocity to the cathode, where they strike with sufficient velocity to oxidize the polished surface and in some cases even soften the cathode stem, causing the cathode to tilt. At the cathode these particles also change their po-

*See L. G. Cole. Experimental Research concerning the Direct, Indirect and Secondary Rays, Archives of the Roentgen Ray, May, 1903, and Archives of Physiological Therapy, Dec., 1906.

†Medicinische Klinik. Aug. 13th, 1905.

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larity, becoming electro-negative and are thus discharged with the cathode rays at an enormous velocity from the concave face of the cathode toward the anti-cathode, causing the metal particles to crowd together on a very small area and striking the target face with sufficient force to come to a white heat. This small white area, which shows plainly when a tube is excited and does not cover an area over one-eighth of an inch in diameter on the face of the target, in a well defining tube, is called the focus. From this small area the X-rays are projected over the entire hemisphere of the bulb in nearly equal strength with the discharged particles. Where these particles strike the surface of the glass, it fluoresces green. This green fluorescence is, however, not a proof of the presence of X-rays, the depth of the color or even the color varying with the chemical composition of the glass. The continuous deposition of the metal particles within the active hemisphere of the bulb causes this to become pink or even smoky in color.

In this case the ray passes through opaque bodies by a transmission of energy which may be illustrated by the old experiment given in physics where when several billiard balls are lying in close contact with each other, if another ball be driven against the first one of the row it stops and the last ball of the row moves on through the transmitted force.

A Comparison of Vibrations.—The following table gives by comparing the number of estimated vibrations, the relative position of the various phenomena produced by disturbances in the ether.*

TABLE OF VIBRATIONS PER SECOND PREPARED BY THE PARIS POLYTECHNIC SCHOOL.

Octaves	Vibrations per second	
1	2	
2	4	
3	8	
4	16	Sound
5	32	"
6	64	"
7	128	"
8	256	"
9	511	"
10	1024	"
15	32768	"
20	1048576	Unknown
25	33554432	Electricity
30	1073741824	"
35	34359738368	"
40	1099511627776	Unknown
45	35184372088832	"
46	70368744177664	Heat
47	140737488355328	"
48	281474976710656	"
49	562949953421312	Light
50	1125899906842624	Chemical Rays
51	2251799813685248	Unknown
57	144115188075855872	"
58	288230376151711744	X-rays
59	576460752303423488	"
60	1152921504606846976	"
61	2305843009213693952	"
62	4611686018427387904	Unknown

The Present Position of Roentgentherapy.†—"In spite of many prophecies to the contrary, Roentgentherapy is still with us. It has passed through the

*Gregg (Med. Standard, June, 1907,) has given an interesting article under the title of "A Scientific Study of X-ray Emanations," from which this table is taken.

†This Editorial from the Illinois Medical Journal, Nov. 1907, so nearly coincides with my own opinions on this subject, that I reproduce it in its entirety.

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stage of shouting and tumult and now has reached a condition of quiet existence in which we may judge of its past results and estimate its present claims of usefulness. What then does it amount to? Has it justified its use and added anything of worth to therapeutics?

"Briefly it may be stated that according to the findings of its early conservative users (and we are only concerned with the claims of this class) Roentgentherapy bid fair to be of more or less benefit in a large class of skin diseases, including some diseases of the appendages of the skin, notably acne, various mycotic and bacterial diseases, various chronic inflammatory diseases, some of the infective granulomata and other connective tissue tumors; in pseudo-leukemia and leukemia; and in malignant growths. How do these prospects look in the light of present experience?

"As to its use in skin diseases, not including for the moment epithelioma, Roentgentherapy has proved its right of existence. While there is some difference of opinion as to its field of usefulness, as there is, for example, to that of every drug, it has been adopted almost universally by dermatologists. There is general agreement as to its value in acne, in tinea tonsurans and favus, in infectious diseases of the follicles of the skin, in blastomycosis and lupus, in chronic scaly inflammatory dermatoses, like chronic eczemas, all extremely intractable dis-

eases for which efficient remedies were greatly needed. This is a formidable group of diseases, but it leaves out of consideration various other conditions in which it is of value, but for which we already have satisfactory forms of treatment, and it also fails to include some very rare diseases like mycosis fungoides, in which X-rays have proved to be the first remedy of positive value. In tuberculosis, aside from lupus, Roentgentherapy may make some claims for usefulness in tuberculous glands and in other subcutaneous foci of tuberculosis. In tuberculous glands it is often of great value. In pseudo-leukemia and in leukemia it is undoubtedly of great temporary value in many cases. In advanced cases the patients may fail to improve, but as a rule great improvement follows its use. This, however, is temporary and sooner or later, it may be months, it may be even several years, the patients succumb. But even granting that X-rays are only palliative in these conditions, Roentgentherapy is still the one specific method which markedly benefits these progressively fatal diseases.

"In malignant growths there is, of course, wide difference of opinion concerning Roentgentherapy. This much must be admitted, for X-rays: they can cause the distintegration of malignant cells, both carcinomatous and sarcomatous, and this process of destruction can be controlled in superficial growths so that these lesions may be destroyed without de-

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stroying their healthy stroma. It follows that at times great improvement can be produced in inoperable lesions and some lesions can be removed in this way which cannot be successfully treated by any method requiring complete destruction of all the tissues in the invaded territory. It would seem, therefore, that the reasonable attitude in inoperable malignant growths is to give such cases the opportunity of receiving any benefit that may come from Roentgentherapy. And there is no doubt that there is real benefit in some of these cases. For example, some of the cases of recurrent carcinoma of the breast first treated with X-rays are still living. In epitheliomata, which from their superficial extent may be inoperable, X-rays offer the most practicable method of treatment. In operable epitheliomas the method of treatment is a question of personal choice. Pusey† has recently reported the result in a series of one hundred and eleven unselected epitheliomas treated more than three years ago with X-rays. Some of these patients have been well for more than five years, and of the entire 111 cases 80 cases, i. e., 72.5 per cent, show after three years, successful results. Leaving out of consideration the palliation which is shown by many of the 31 cases which he does not include among the successful results, that is a record which shows that Roentgen-

†International Dermatological Congress, September, 1907.

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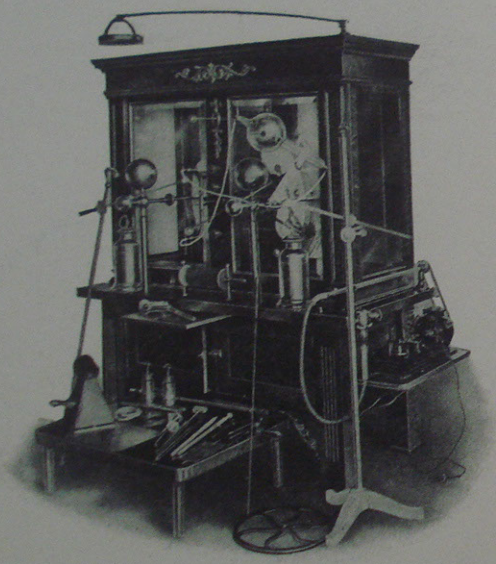

Modern Static Machine. See Page 32.

therapy in epithelioma is entitled to respectful consideration.

"There would seem to be no room for doubt that in the present state of our therapeutical equipment the X-ray is an agent which has a wide field of usefulness in the hands of conservative and intelligent users."

Choice of Apparatus.—The choice of apparatus is largely influenced by the location of the physician and the character of the X-ray work he intends to do; that is, whether he intends to give his whole time to special work in this line, or whether it is to be merely an adjunct to his other practice.

The X-ray is satisfactorily generated either by means of an induction coil, or by a static machine.

If the physician has been in the habit of using a static machine to give treatments with, he would by reason of this familiarity get better X-ray results with it than with a coil. Sometimes, too, by reason of location there is no choice and only the static machine can be used. This is true in towns where there is no electric light plant or where it is in operation only part of the day.

The static machine can be operated by water, gasoline or other form of motor or even by hand. It makes a good appearance in the office and is useful in giving other treatments.

On the other hand, the static machine does not have the same power that the coil has; is more often

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out of order, and it requires a relatively longer exposure to obtain the same results. Therefore, if the physician is where he can obtain a steady electric current both day and night and especially if he confines his work to electro-therapy, he should have an induction coil. It is always ready for use; easily managed; and possesses such power that skiagraphs are made in a fraction of the time required with the static machine.

It is a noteworthy fact, that nearly all men making a specialty of the X-ray use the induction coil; the exceptions being principally men who had achieved reputations in the use of static electricity before the X-ray was discovered; and were consequently able to secure better results with the static machine than with the coil, because of being accustomed to the former. The personal equation is in all cases really the chief factor, whatever style of apparatus is used.

In these pages, where no reference is made to the contrary, it will be understood that the directions are based upon the application of the ray as generated by means of a coil.

Description of Static Machines.—Most of the static machines of the present day are of the Toepler-Holz type as shown on page 30. No friction is needed but an initial charge is required. The stationary plates alternate with the movable ones and are somewhat larger in diameter. To make the

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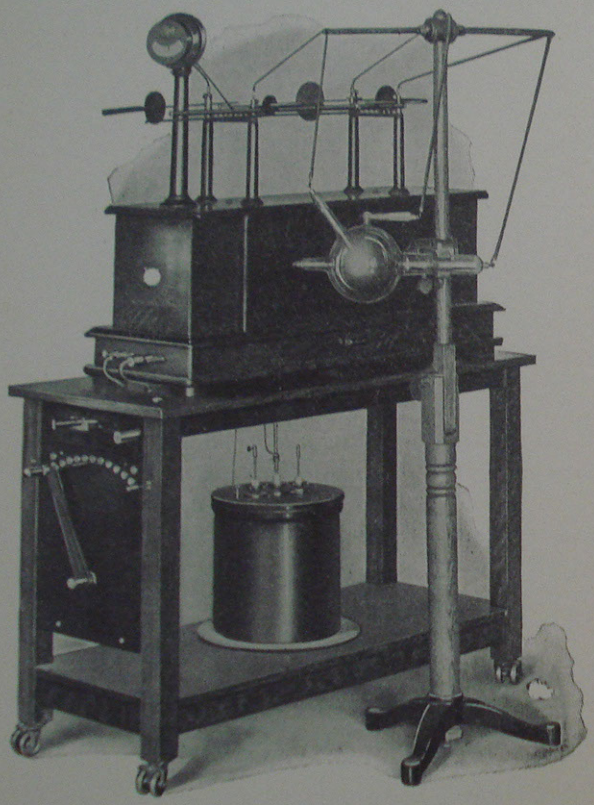
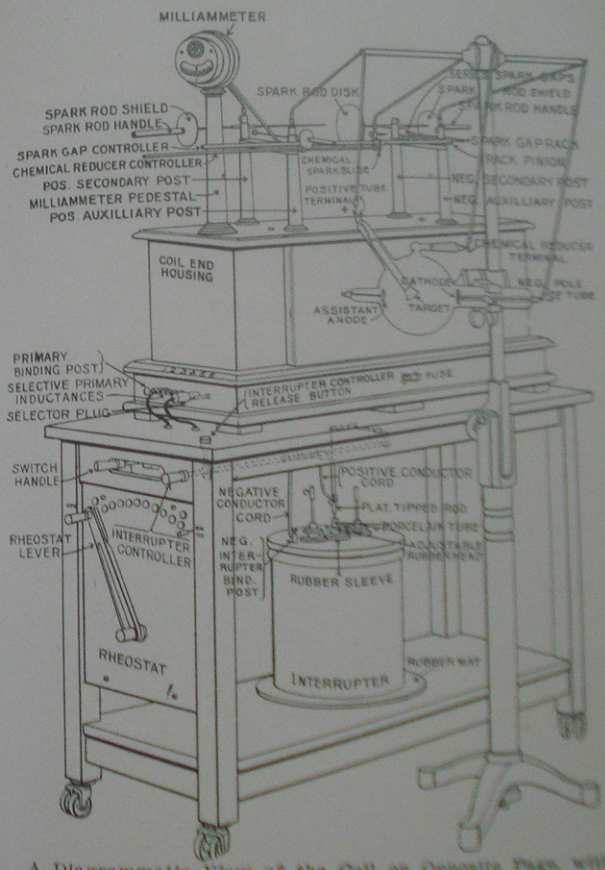


X-ray Coil with Electrolytic Interrupter.



A Diagrammatic View of the Coil on Opposite Page, with Parts Named.

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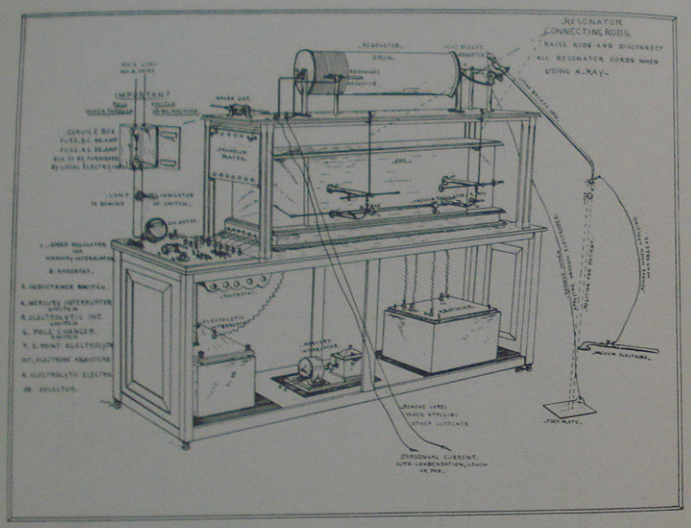
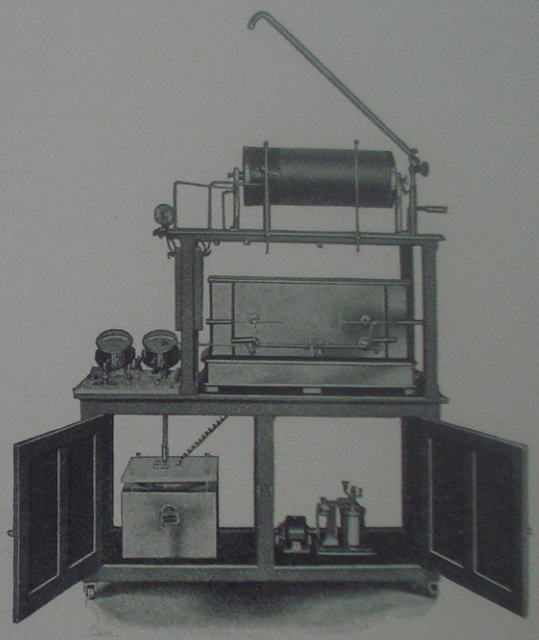


An Outline Cut of Coil on Opposite Page with parts Named.



X-ray Coil with Both Electrolytic and Mercury Interrupter, and with High Frequency Resonator on Top.

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removal of these convenient, they are split in the best types. When the movable plates are rotated an electro static circuit is set up between the positively and negatively electrified surfaces, which may be under the brushes on opposite sides. When these charges reach opposite sides, they are discharged and conducted to the spark rods. As the speed of the machine is increased, the charges on the electrified surfaces increase automatically until a balance is obtained between the further accession of charge and the leakage which takes place. This leakage limits the maximum electromotive force obtainable by the machine.

Description of Coil.—For an extensive description of apparatus, the reader is referred to the catalogues of the various dealers in X-ray apparatus.

The ordinary coil consists of a core of soft iron wire or strips over which is wound the primary of one or more layers of coarse copper wire, and a secondary coil of fine wire.

The posts on top of the case containing the coils are called the terminals or poles and are connected with the terminals of the secondary coil. They are set at a distance apart commensurate with the sparking capacity of the coil.

Thus a 12-inch coil, so-called, is one where these posts are set at a distance of 12 inches apart so that when the coil is in operation a 12-inch spark may be made to pass between the terminals.

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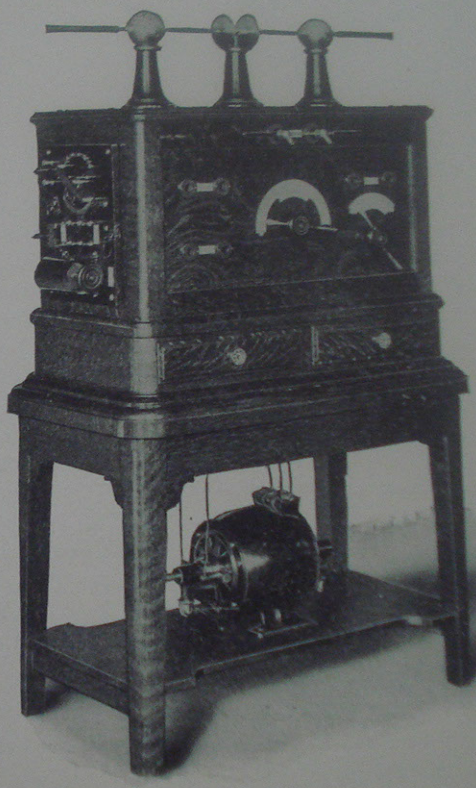
The manufacturers usually make the sparking capacity of the coil somewhat greater than the distance at which the posts are arbitrarily placed, so that a 12-inch coil, so-called, would ordinarily be capable of delivering a 13 or 14-inch spark, were the terminals so placed.

Variable Primaries.—Walter found that tubes of different degrees of hardness would not work well on a coil having a fixed number of primary turns or inductance and designed a method of winding (now used almost entirely in the highest grade of coils), whereby different layers were wound each with a different number of turns of wire. Taps were taken out from each layer and brought to a selector switch, where any layer or number of layers might be selected, as best suited to the particular tube used. Hard tubes are best operated with a single layer while soft tubes need considerable inductance, obtained by combining several layers.

The secondary of the coil is usually wound in sections or in a large number of thin discs and insulated with vaseline or wax.

Portable Coils.—Portable coils consist of three types; 1st, regular induction coils made very compact and with a view to space economy. Such an outfit consisting of 15-inch coil, rheostat, electrolytic interrupter, tube-holder, switchboard and one hundred feet of cable, all to fit into a carrying case, 12x



Special Cabinet Coil, Tesla type, for X-ray and all forms of High-Frequency Current.

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16x36 inches long, is shown herewith. When the direct or alternating current service is available, it can be connected to same, and where these are not available, an electric runabout, delivering a current at about 80 volts, may be used. For treatment work a 6-volt storage battery and mechanical vibrator may be substituted. During the past four years this outfit has been called into service by a number of Chicago radiographers and has proven its practicability.

The second type of portable coil, the first example of which appeared in the Kinraide coil, employs a small step-up transformer, with condensers and Tesla coil. A special type of X-ray tube is required with these since the current is alternating or rather oscillatory.

The third type is known as a Tesla oscillator and consists of a vibrator coil with considerable inductance, a rather large condenser and a Tesla coil. The character of the discharge from this is the same as the second. For treatment work the apparatus is quite well adapted and weighing from 50 to 80 pounds, is quite portable, but for radiographic work its field is limited.

Interrupters.—In using the coil especial attention is given to the character of the interrupter employed. Its purpose is to suddenly and completely break the current into a succession of impulses, which cause the iron core of the primary coil to become

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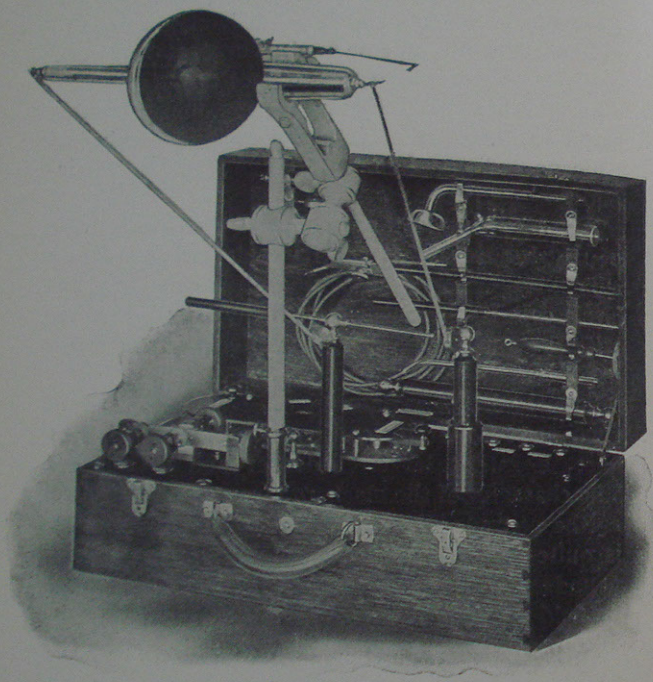
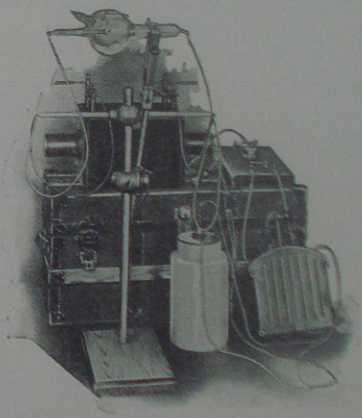


Portable X-ray and High Frequency Coil; Tesla Type.



Portable Induction Coil with Electrolytic Interrupter.

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magnetized and demagnetized many times a minute.

Simultaneously with each making and breaking of the current a secondary current is induced in the secondary coil and the more rapidly the magnetic lines of force pass to and fro from the core the greater the volume of induced current.

In small coils the old-style vibrating break, like the spring on a Faradic battery, is still found satisfactory, but the type of circuit-breaker in general use is either of the mercury-turbine or electrolytic form.

The mercury-interrupter, which may be used only with the direct current, consists of a pot containing mercury, covered with alcohol or petroleum.

In the center of this is a small turbine, which when rapidly revolved draws the mercury in the bottom of the pot upward and ejects it in a fine stream from the nozzle against a segmental ring. Whenever the mercury jet strikes a segment, the circuit is closed. The sectional cut here shows it quite plainly. The number of interruptions may be varied in number from 1,000 to 3,000 per minute. The mercurial turbine interrupter works quite noiselessly, but is, however, subject to clogging of the mercury and also to explosions of the oil.

Several practical forms of rotary mechanical interrupters have been devised recently, one of which at least is adapted to operate on either direct or alternating current.

X-ray Coil.

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The electrolytic interrupter which gives the highest known number of interruptions (1,000 and 2,000 per second), depends on an entirely different principle. With this type of interrupter the liquid surrounding the small area of the positive electrode is converted into a gas bubble, which circulates same and interrupts the circuit. As soon as the current is interrupted, the magnetic field of the coil collapses, causing the secondary to discharge; the gas bubble is forced upward to the surface of the fluid, which rushes up to the anode, again repeating the phenomenon. In its simplest form the electrolytic interrupter consists of a glass jar filled with a solution of sulphuric acid, into which two electrodes of different areas are suspended. The large electrode, a piece of sheet lead, is connected to the negative pole, the small electrode, a short piece of platinum wire, is connected to the positive pole. The platinum wire may be fused into a glass or porcelain tube, or it may slide through a tight-fitting annular opening, thus making the positive area variable. If the self-induction of the coil is not too small, a voltage of from 30 to 60 volts is sufficient to start the interrupter. The frequency of the interruptions depends on the self-induction and increases with a decrease in the latter. The interruptions are very regular and perfect, and so sudden and entire, that no condenser is required, which simplifies and reduces the cost of the apparatus considerably.

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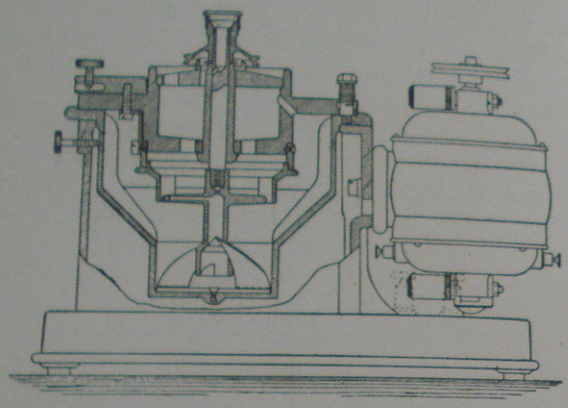
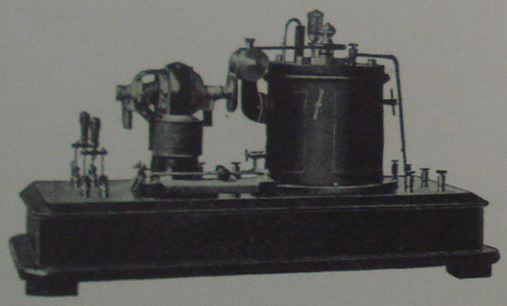
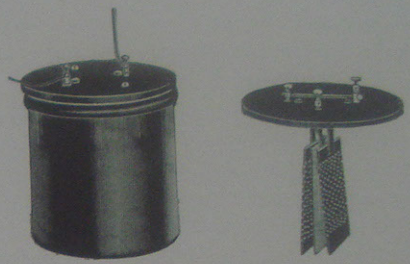


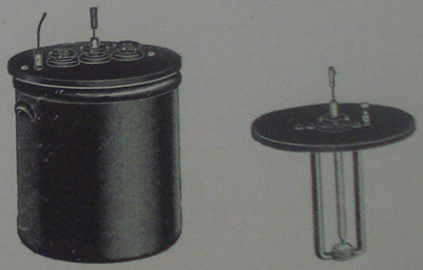
Sectional view of Mercury Interrupter.



Mercury Interrupter.



Rectifying Valve.



Electrolytic Interrupter.

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Valves and Rectifiers.—If by chance the negative pole be connected to the positive pole of the electrolytic interrupter, the platinum will disintegrate rapidly. It will even fuse and form a round bulb. For this reason it is not economical to attach the electrolytic interrupter directly to an alternating current. The latter must be converted by a rectifying valve, a form of which is shown here; or a set of four such valves may be combined in a complete rectifier, delivering a direct current.

A diagrammatic representation of how this is accomplished is shown in the illustration.

Each cell consists of a lead and aluminum electrode immersed in a solution of ammonium phosphate. The action of each cell is, that, although the current may pass freely from the lead to the aluminum it cannot pass from the aluminum to the lead, because of the oxide of aluminum which forms within one one-thousandth of a second on the surface of the aluminum, and being a complete insulator, prevents the passage of the current to the lead electrode. By selecting suitable electrodes and chemicals the rectifier may be used even up to currents of 220 volts.

Rheostat.—The amount of current which is allowed to flow through the apparatus is regulated by means of the rheostat. (See the various illustrations of coils.)

One form is inductively wound, thus serving as a

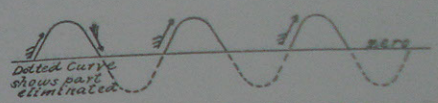

Diagram Showing Action of Rectifying Valve. A Pulsating Uni-directional Current Is Delivered.

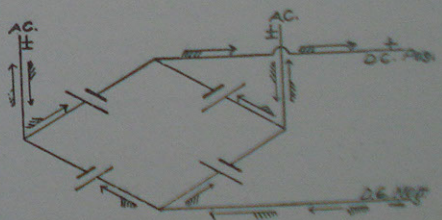

Diagram of Complete Rectifier.

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voltage as well as current regulator. As the arm is moved from left to right the resistance is gradually lessened, increasing the voltage and current flow to the required amperage.

To Tell Which Terminal of the Coil is Positive.—The terminals of the secondary coil consist of a pointed rod for the positive pole and a rod ending in a flat disk for the negative pole. It frequently happens that the coil is connected up so that the disk has become the positive pole and as it is important to know the respective poles in order to properly connect an X-ray tube, the following simple method is given:

When the spark is made to pass between the terminals, if it strikes on the face of the disk at or near the center (never on the edges), then the current is passing from the point to the disk and the point is positive and the disk negative. If the current is reversed, the spark comes from the edge of the disk and never from its face or center, and under this condition the disk is positive and the point negative.

At the present time nearly all coils are provided with a pole-changer so that, in an instant, point or disk may be made positive or negative as desired.

To Tell the Poles on a Static Machine.—To tell the poles of a static machine, requires very close observation of the characteristics of the sparks, while they pass between the balls of the sliding

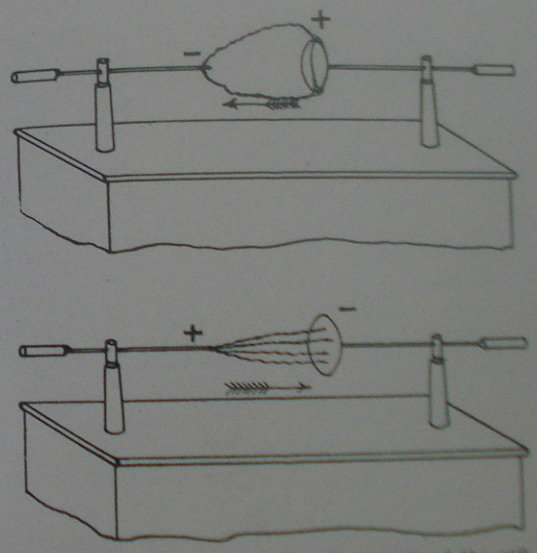

Diagram showing how to tell the terminals of the coil by the direction of the spark. (Page 54.)

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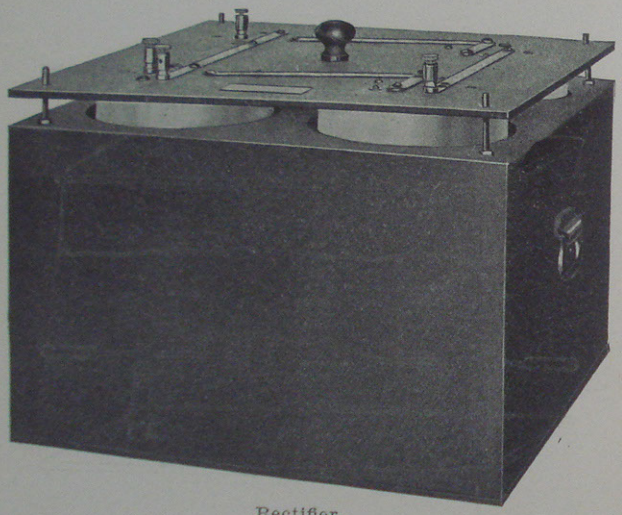
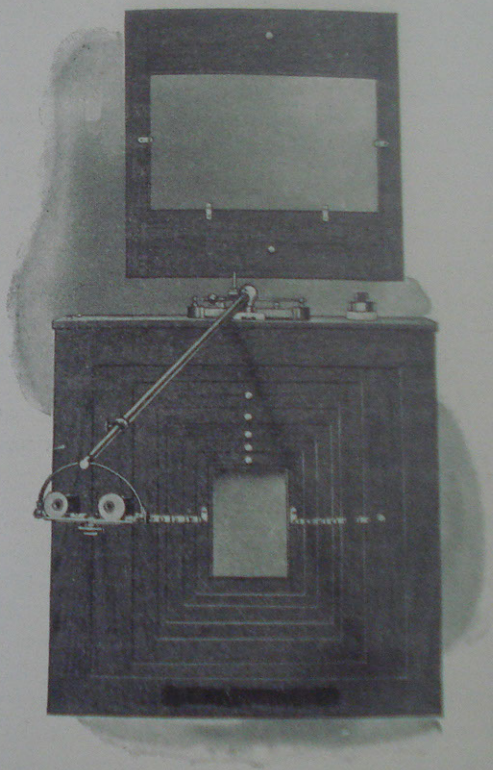


Rectifier.



Stereoscopic Shadow or Illuminating Box for Examining X-ray Plates.

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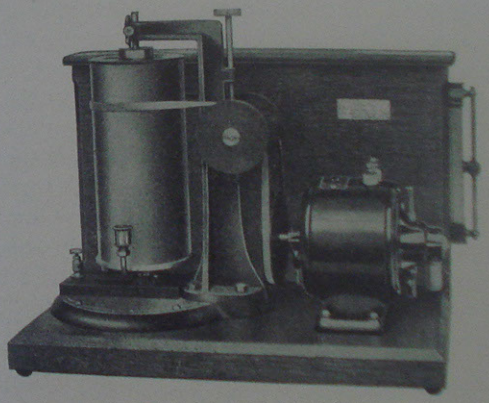
rods. At the positive terminal the sparks will look thin and of a purple color, while at the negative terminal they seem fat and white.

Spark-Gaps.—Nearly all coils are provided with adjustable rods at the side of each terminal from the base of which the X-ray tube is connected. These are called adjustable spark-gaps, and by separating them from the terminals of the coil, additional resistance to the current is placed in the circuit. Because there is one on either side, they are frequently called parallel spark-gaps.

When the tube is connected it is customary to separate one or both of the spark-gaps a little (¼ to ½ inch), and then if on starting the machine the tube does not light up, the lever of the rheostat is slowly moved around until sufficient current passes to overcome the resistance of the tube.

Multiple Spark-Gaps.—In radiographic and fluoroscopic work when a low vacuum tube is used, because of the low resistance, the current induced in the secondary (when closing the primary circuit in the interrupter), and which is in opposition to the current passing through the secondary when the primary circuit is interrupted, will cause a still further reduction of the vacuum in the tube and consequently less penetration. The voltage of this "make spark" is never over 3 inches in a well designed coil, and to rid the circuit of this, a series



Mechanical Interrupter.

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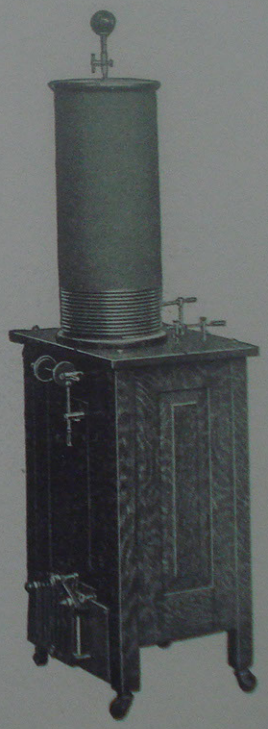
of small brass balls is introduced. These balls are set only a few millimeters apart and while they have no appreciable resistance to a unidirectional current, a high resistance is set up to an oscillatory discharge, and a few of these gaps introduced at the negative or cathode side, will prevent the so-called inverse discharges and aid in steadying the vacuum of the tube. A single spark gap will answer within certain limits, but is not satisfactory for tubes which are likely to be reduced by passing a heavy current through them. The Coil shown on page 34 is equipped with such series multiple spark-gaps.

When a tube is in operation and a given amount of current has been required to excite it, if the terminals of the coil are gradually brought together, there comes a point when a spark will pass between them. This has been utilized to roughly indicate the degree of vacuum of the tube. Thus if a four- or six-inch spark passes, the tube is said to "back up" a four- or six-inch spark.

Automatic Time Switch for X-Ray Work.—Among the ingenious contrivances invented for use by electro-therapists, may be mentioned a clock which automatically stops the X-ray machine at a given time. The face of the clock is equipped with a movable ring holding a contact point, which may be placed a fraction of a minute or several minutes ahead of the minute-hand, according to the length of treatment to be given. When the minute-hand



Author's Combined Tesla-D'Arsonval-Oudin Apparatus for X-ray and High Frequency Therapeutic Use.

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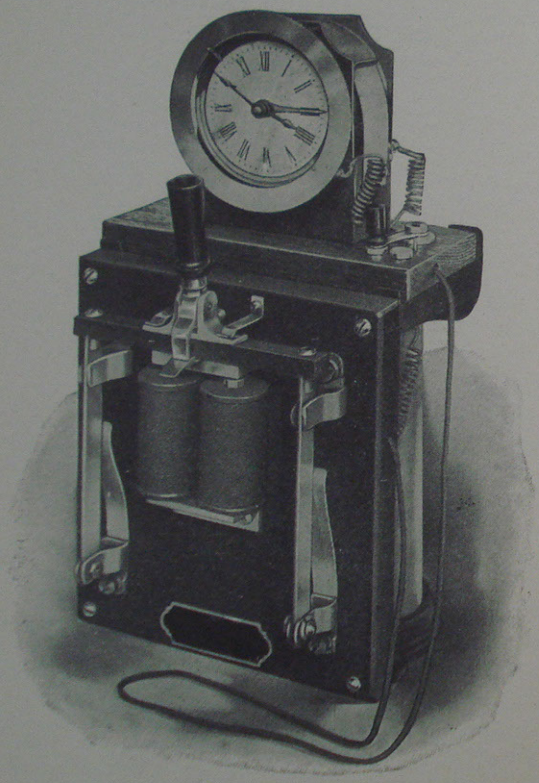

Automatic Time Switch.

moves forward and touches this point the current from the dry cells in the subbase causes an electro-magnet to release the knife switch, which opens and cuts off all current supply to the apparatus. This may be used on any kind of current and for coil, static machine, wall-plate, etc.

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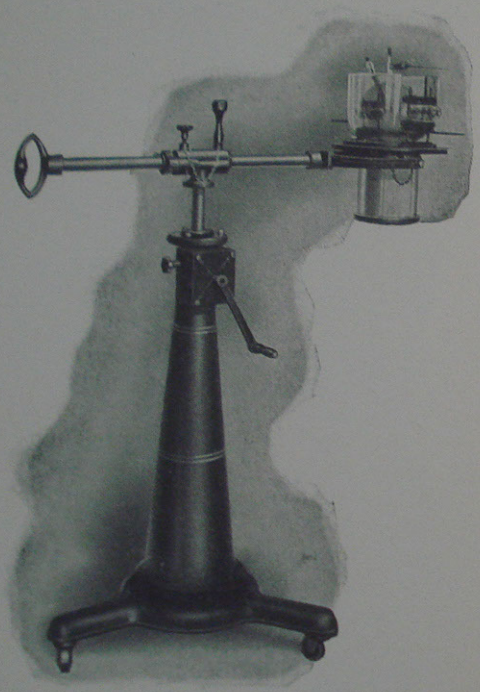

Compression Diaphragm. See Page 89, Section 6.

CHAPTER II.

X-ray Tubes—To Tell a Good or Bad Tube—How the Tube is Connected—Hemispheres—High and Low Tubes—Focusing—Distance to Place Tube From Surface Treated.

X-Ray Tubes.—X-ray tubes are constructed in various shapes and sizes, some with and some without a device for regulating the vacuum. It is not desirable in this short article to consider extensively the various makes, but the regulating tubes are always to be preferred.

Several shapes of X-ray tubes are shown in the illustrations. The metallic disk in the center is called the target or anti-cathode because upon it is directed the stream of cathode or negative rays which are produced when the tube is in action. On the face of the disk, which is made of a metal of high atomic weight, platinum being ordinarily employed, a small spot may be seen where the cathode rays impinge, being focused there by the concave form of the cathode. The anode or positive pole is opposite the cathode. Outside of the tube the anode and target are usually connected so that the target is to all intents and purposes also the anode. (See frontispiece.)

A tube used on a coil requires a much heavier target than one used on a static machine.

Some tubes have been manufacturel recently with a thick button of iridium-platinum covering the

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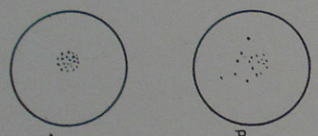
point of focus on the target. With these tubes 25 to 40 milliamperes of current have been run through without melting the target and without producing an immediate drop in the vacuum.

To Tell a Good or a Bad Tube.—A good or a bad tube may be known by the character of the spot on the mirror-like surface of the anti-cathode, where it is bombarded by the negative rays. If the spot is compact so that the charge is delivered over a small area, the tube is much better than when the rays scatter over a considerable surface, e. g., where part

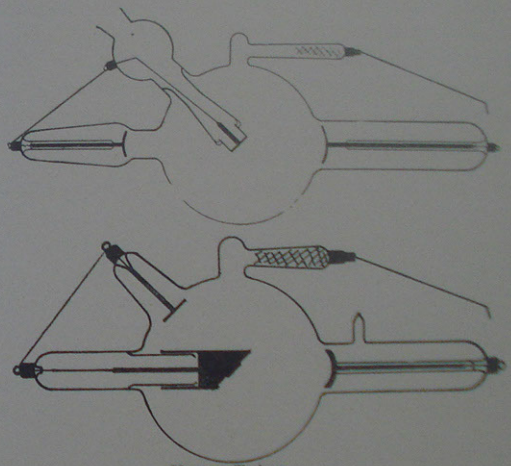


of them are delivered in one spot with the ragged outline of scattered ray-marks around it. If the spot is circumscribed, the tube focuses well, and since the X-rays are generated from this point on the target, they will be more compact and cause less error and distortion than when they come from several spots.

It is but fair to state that this applies especially to the skiagraphic value of the tube, or definition. Therapeutically, the scattering of the rays is of minor importance and in some cases has even been sought by the manufacture of tubes with flat or convex cathodes.*

*Rollins. *Notes on X-light.* P. 311.

How the X-Ray Tube Is Connected.—The tube is connected so that the cathode receives the current



X-ray Tubes.

from the negative terminal of the coil or static machine.

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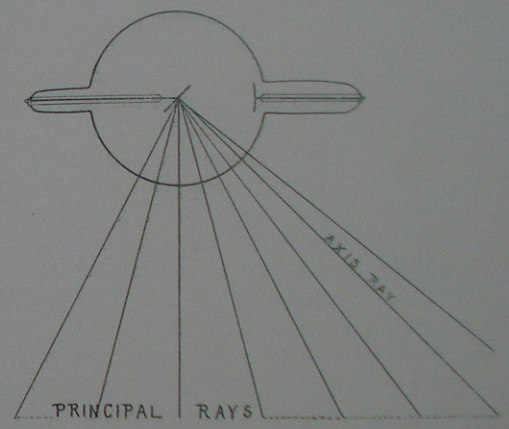
The conducting cords should be covered with rubber tubing for convenience in preventing shock if they are touched when the tube is in operation and also to lessen the waste or dissipation of the current.

A new form of cord in which the rubber covering is vulcanized directly over the strands of copper wire, and this covered with a hard linen braiding, has been placed on the market and is proving very satisfactory, also metal self-winding tapes.

Hemispheres of the Tube.—When the tube is excited it is noticed that there are two distinct hemispheres to be seen, the plane of division being that of the anti-cathode. The hemisphere in front of the target is called the active hemisphere and is that with which we are especially concerned. The X-rays are given off from the point on the target where the cathode stream strikes and pass in straight lines in every direction throughout the active hemisphere. They are not capable of being reflected, refracted, or otherwise diverged from their course, although where they strike solid particles secondary rays are generated.

High and Low Tubes.—The terms high and low refer to the degree of vacuum within the tube, the one with the high vacuum is called a high tube and offers greater resistance to the passage of the current and therefore requires greater energy to excite



Showing Axis Ray and Other Rays of Practically Equal Intensity.

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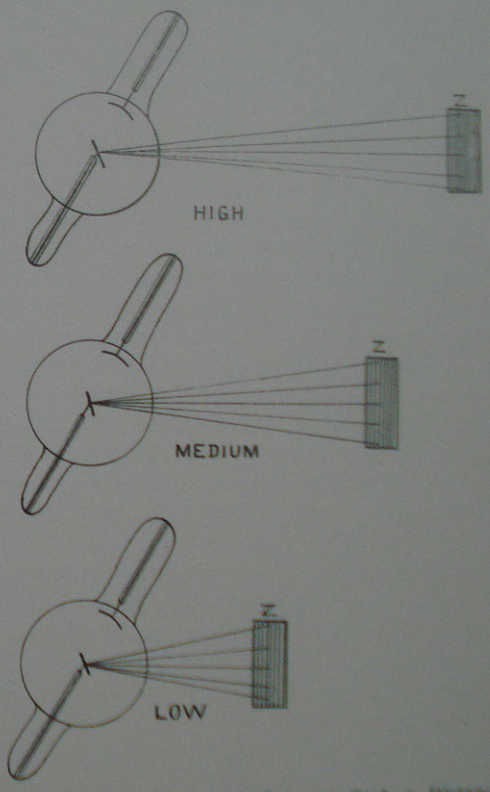
it and the rays given off from it are correspondingly stronger and more penetrating. Formerly the terms hard and soft were used to designate high and low tubes, but these terms are gradually being discarded.

Focusing.—In order to properly consider the adjustment of the tube in relation to the patient, either for therapeutic or skiagraphic work, it is necessary to know where the most direct rays are delivered. There must, of course, be one axis ray and this is perpendicular to the target at the point from which the rays are generated and it will be found that the cathode stream bisects the angle between this axis and the plane of the target. For all ordinary consideration the rays 10 or 15 degrees back of the axis toward the anode are of essentially the same directness and penetration and are usually employed because the shape of the tube makes them much more accessible than the axis ray.

For satisfactory skiagraphic work, the photographic plate should always be perpendicular to the absolute axis with the axis passing through the central portion of the part to be skiagraphed. This would make the plane of the target and that of the plate parallel to one another.

It is also possible to get a skiagraph without distortion if the shortest line from the point on the target to the plate is perpendicular to the latter and passes through the center of the part skiagraphed.*

*Juettner, Mod. Skiagraphic Technique, Archives Phys. Ther., Nov., 1905.
Also see Chapter IV.



Illustrating the Placing of the Tube at Such a Distance that the Zone, Z, Includes the Area to Be Treated.

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For therapeutic purposes the rays should be considered as a cone, the apex being the point of generation on the anti-cathode and the base spreading over the surface under treatment.

Distance.—The tube is usually placed at a distance of from six to ten inches from the part to be treated.

The distance is ordinarily measured from the outer wall of the tube, but owing to the variation in the diameter of tubes, it seems to me that the more reliable method is to consider the distance from the point of origin of the rays, i. e., the target. This gives a fixed point to measure from without considering the diameter of the tube.

Counting from the target,* the ordinary distance from the part treated would be between six and twelve inches. Whether a high or low tube is used is largely to be viewed from the standpoint of distance.

If a low tube of very slight penetration is employed, it may be brought very close to the surface under treatment and a large quantity of weak but readily absorbable rays will fall upon the lesion.

If a medium or high tube is used and the distance at which the patient is placed is sufficient it will overcome the greater power of the rays and their

*Custom has so thoroughly established the stating of the distance from the tube-wall, instead of from the target, that in Part II of this work the older method has been adhered to.

effect will still be expended upon the surface, but the rays will be fewer in number.

In other words, the real question must be the consideration of the rays from the standpoint of where they are of that slowness of speed that they are most suitable for absorption; and to place the tube at such a distance that this zone will include the part to be treated. In case the lesion is within the body, then a higher tube would be used, but at a considerable distance so that the rays would pass through the surface without exerting too much effect there before influencing the point within, where they are really needed.

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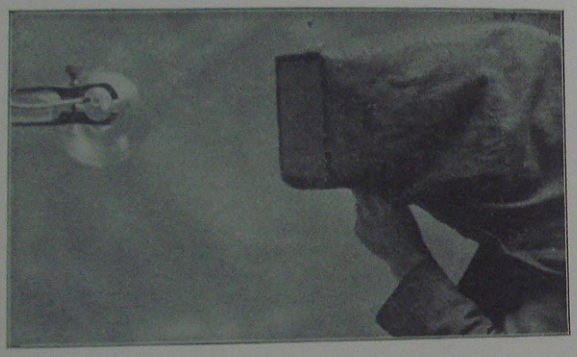

King's Substitute for Dark Room.

CHAPTER III.

The Fluoroscope—Substitute for Dark Room—Fluoroscopic Examinations—Care of Fluoroscope—Regeneration of Fluoroscopic Screens—A Satisfactory Screen—Penetrometers—Methods of Measuring the X-ray.

The Fluoroscope.—The X-ray is not perceived by the human eye as light and therefore it has been found necessary to make use of some interposed substance to make the effects of the ray perceptible.

For this purpose a screen of barium platinocyanide is used, which gives a greenish fluoroscence under the ray.

When a substance is placed between the screen and the lighted tube, shadows appear on the screen where the rays have been intercepted by the object. These vary in density according to whether the rays have been partially or entirely stopped.

The screen can only be used satisfactorily in a dark room.

For convenience in using it in rooms where only partial darkness is obtainable the screens have been mounted on boxes as shown in the illustration, the case making sufficient darkness to enable one to make some use of the fluoroscope even in a comparatively light room.

Substitute for Dark Room.—Dr. King (J. A. M. A., Nov. 3, 1906) describes a hood to fit over the

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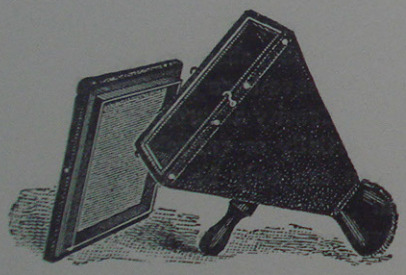

Fluoroscope.

fluoroscope and also over the operator's head as shown in the illustration, whereby the observer, being in absolute darkness, can see readily the image on the screen even in a perfectly light room.

Fluoroscopic Examinations.—The general principles underlying fluoroscopic examinations are similar to those governing the taking of skiagraphs.

The part to be examined should be placed so that the axis ray passes through its center, and perpendicular to the center of the fluoroscopic screen. Instead of the axis ray, any of the principal rays may be utilized, the requirement being that the ray looked upon as the central ray should pass through the center of the part examined and be perpendicular to the screen.

The room should be dark and the fluoroscopic screen should be placed in direct contact with the object, with the latter between the screen and the tube.

Use a medium or high tube, according to the thickness of the part examined, in order to get sufficient penetration.

In examining thick parts it will require a moment or two before the rays will penetrate in sufficient quantity and for the eyes to become accustomed to the conditions present.

With a low tube the bones appear very black. As higher tubes are used they appear more grayish

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Making a Fluoroscopic Examination of the Chest.

until one sufficiently high may be used as almost entirely to penetrate the bone.

Care of Fluoroscope.—The fluoroscope should be kept in a dark place, and if possible a moist one, of cool or moderate temperature.

Regeneration of Fluoroscopic Screens.—Bordier calls attention to the gradual change which takes place in the screen, from its original light-green color to orange and finally to dull gold.

This he proved experimentally to be due to the driving off of the water of crystallization present in the barium salt.

Attention is called to the fact that in the ordinary screen the salt is covered and mixed with collodion, and is therefore not accessible to moisture.

If the physician wishes to regenerate his screen rather than purchase a new one it may be done by breaking it up in small pieces and placing in a suitable vessel.

Then pour in hot water, which will dissolve the barium platino-cyanide, which crystallizes out on evaporation with its original color and fluorescence restored.

A Satisfactory Screen.—Bordier further tells a simple method of making a satisfactory screen by merely soaking heavy blotting paper in a saturated solution of the barium salt.

Both sides become coated with the crystals and

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when the blotting paper is split in two, two screens are produced.

The coated side is covered by glass, and the screen is complete.

When regeneration is required, the uncoated side is moistened and the result quickly accomplished.

Penetrometers.—Various methods of determining the penetration of the X-ray tube have been devised.

The ordinary method has been for the operator to use his own hand or arm, but experience has taught us that this is an expensive form of penetrometer.

Piffard* uses a section of a radius and ulna mounted on a thin board, as a simple and reasonably satisfactory substitute for the operator's hand.

Many instruments for this purpose are based upon the arrangement of lead, silver or aluminum in different thicknesses so that the penetration of the tube may be known from the number of layers of the metal which it passes through.

Several forms of penetrometers are worthy of special mention. Benoist devised an instrument in which a silver disk 0.11 millimeter thick is the standard. Surrounding it are layers of aluminum, running from a single layer up to 12, each section marked by a lead number.

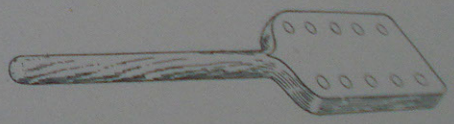
In use the dial is rotated until one of the sections corresponds in shade with the portion in the center,

*N. Y. Med. Journal, Jan. 6, 1906.

the lead shield allowing only one section to be seen at a time.

The numbers from one to twelve cover every degree of penetration required in radiotherapy or radiography. Since the step from one field to the other shows but little difference, Walter reduced the number of the fields to six, by omitting the uneven numbers, thus increasing the contrast.

A tube showing five of these fields is sufficient to penetrate 10 to 12 inches of tissue, while a tube showing the first field only must be used for superficial treatment. Between these two extremes, the penetration required to reach a lesion situated at a certain depth within the tissues may be easily calculated.



The penetration gauge here shown may be used with any fluoroscope. The scale is divided into ten progressive steps and covers the entire range between surface treatment and taking a radiograph through a thick pelvis.

When calculating the necessary penetration required; for instance, in radiographing a chest, due allowance must be made for the fact that the rays do not have to penetrate dense tissues, which tend to

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diffuse the X-rays as in the abdomen and pelvis and that for this reason less penetration is required.

Definition of a tube may also be ascertained with a penetrometer. Tubes with a small well defined focus will show the outlines of the different fields penetrated, sharp and clear, while those tubes which have a scattered focus or secondary rays will show hazy outlines for the fields even when the rays are very penetrating.

Since the terms soft, medium and hard, as applied to X-ray tubes, are rather indefinite and allow too much variation, they may be given in terms of the Benoist or Walter scale, or according to the penetration gauge illustrated:

	Benoist.	Walter.	Gauge.
Soft or low tubes.....	1— 2	1	1— 2
Medium	3— 5	2—3	3— 4
Hard or high.....	6—12	4—6	5—10

The amount of current which may be safely used in treatment varies from one-quarter to two milliamperes and should be carefully noted by a milliammeter, a type of which is shown on page 160.

Under the chapter treating of the protection of the operator may be found a description and illustration of Pfahler's arrangement, by which, with a mirror placed at an angle, the Benoist scale may be used without the physician being exposed to the rays.

Holzknecht devised what is called a chromoradiometer based on the color changes exhibited by certain salts when acted upon by the cathode rays. This device consists of a small capsule said to contain potassium sulphate and a small amount of some other potassium salt; the whole held together with copal varnish and enclosed in celluloid. There is also a scale ranging in color from a greenish-yellow to a deep green and divided arbitrarily into 24 units.

The capsule is placed on the part treated and after exposure it changes in color, growing darker with stronger rays. It is then compared with the color scale and the intensity designated according to the number of units as 4H or 6H.

An easily constructed and efficient penetrometer is suggested by Dr. J. H. Carpenter. He uses 12 inches from the small end of an ox tail, which is cut in two 6-inch pieces and set in a block of maple or other dense wood, 1¼x3½ inches, and 6 inches long. A handle 5 inches long is fashioned on one end and two parallel holes 1⅛ inches in diameter are bored into the other end, deep enough to admit the two pieces of ox tail, which are first prepared by immersing them in formaldehyde for a few hours, then drying, when they are placed in the holes and hot paraffin poured in and allowed to cool.

This has the advantage of presenting bones ranging in density from those of the shafts of the fingers to the heaviest joints of the wrist. The wood offers

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about the same resistance to the ray as the flesh of the hand and wrist.

Many operators make a simple form by using narrow strips of lead-foil glued on cardboard. The first row consisting of one layer; the second of two layers, and so on.

The reader is referred to the various instrument houses for different devices, if his own ingenuity is not sufficient to produce one.

In a general way, one becomes sufficiently accustomed to noting the color of the tube, the amount of current employed, the separation of spark-gaps, etc., to answer all ordinary purposes.

Instruments for Measuring Quantity of X-Rays.* —Dunham† makes use of "a selenium cell, which is placed inside of a wooden pill-box and surrounded by tungstate of calcium. This and a volt meter are placed in series in a direct current of not less than 60 volts. When this is placed before an X-ray tube the tungstate of calcium is caused to fluoresce and the light derived from the fluorescence causes the resistance of the selenium cell to be reduced (as does any light). The fluorescence is, of course, much less powerful than a 15-candle-power lamp. This lowering of resistance in the cell allows the current to flow more readily, and this can be directly

*This subject is thoroughly discussed in Archives of the Roentgen Ray, June, 1906. Also see article by Durand, Archives de l' électricité Médicale, May 25th, 1906.
†Quoted from abstract in Journ. A. M. A., Sept. 15th, 1906.

measured by a very sensitive volt meter. The next instrument depends for its action on the fact that a 2 per cent solution of iodoform in chloroform is very easily and uniformly affected by the X-rays. Its appearance when so treated varies from a light pink to a very dark reddish brown. The second instrument is as follows: The selenium cell and volt meter are put in series as before, but no fluorescent salt is used. The wooden box is removed, and the cell placed in a light, tight box. The resistance of the selenium cell is reduced by the electric lamp beyond a partition. The light must pass from a lamp to a cell through the bottle because of the small aperture. To make this doubly certain the opening is fitted with a small cylinder so that the rays must pass as desired. When it is desired to measure a given dosage all that is necessary to do is to fill the bottle, place it in the box and make the reading. The solution is clear and practically all the light passes to the cell. The resistence drops and the voltage as read on the meter goes up. The bottle is now removed, laid on the surface of the patient near the part to receive irradiation. After the treatment it is quickly placed in the box and the reading taken. The quantity of X-rays will be read by the difference of the voltage before and after the exposure."

Johnston also uses a meter based on the action of

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light on a selenium cell and the use of a fluorescent screen as a measure of the quantity of X-rays.

Piffard uses a brass ball one and one-quarter inches in diameter and suspends it about four inches in front of the tube (just within the influence of the active hemisphere). This is connected to an electroscope by a cord about eight feet long, and the angle as indicated by the scale on the electroscope gives a reliable measure of the charge and varies directly with the current passing through the tube.

CHAPTER IV.

Skiagraphs—The Plates—Fundamental Principles—To Obtain a Proper Image—Time of Exposure—Value of the Skiagraph in Dislocations and Fractures—The Skiagraph in Legal Practice—What Is Necessary to Make the Plate Competent Testimony—Developer Formula.

Skiagraphs. The taking of X-ray pictures is an art and a science by itself and quite distinct from the therapeutic use of the ray, to which this book is devoted; therefore, I introduce only a few sections on this subject.

The Plates. The plates used for skiagraphic work are similar to photographic plates except that they have a heavier coating of the bromide of silver gelatin.

To enable the plates to be handled in daylight they are placed in two envelopes, an inner black one and an outer orange one. The plates should be kept on edge in the dark-room, and preferably inserted in the envelopes just before use, although it is customary to keep a few of them ready in the envelopes for convenience. The plates are placed with the sensitive side to the smooth side of the envelope, thus always enabling the operator to know which side to place uppermost and also avoiding any shadow of the envelope flap showing on the plate.

Where the operator takes an occasional plate and

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does not do his own developing, the plates in their envelopes should be kept in a lead-lined box, and away from the range of the active hemisphere of the tube.

Formula For a Good "Developer."—For the benefit of the operator who wishes to do his own developing, the following reliable formula is given:

℞	Edinol	Grammes	6
	Hydrokinone	"	10
	Acetone sulphite	"	45
	Potassium carbonate, C. P. (dry).....	"	100
	Distilled water	"	1,000

M. Sig. Use undiluted, at a temperature of 60° Fahrenheit.

Fundamental Principles. There are a few fundamental principles that it is necessary to bear in mind in order to get a good radiograph.

1. The tube must properly balance the generating apparatus, and emit a goodly volume of rays of the necessary penetration and intensity. Thus a tube with a light target will act nicely on a static machine where it would be useless on a coil and vice-versa.

The vacuum used is relatively higher than for therapeutic purposes in order to have rays sufficiently penetrating pass through the object and still act upon the bromide of silver on the plate.

2. The plate should be relatively farther away from the tube than the screen is in fluoroscopic examinations. The farther away, the better the definition (sharpness of outline), and the less the part is magnified.

3. The thicker the part the higher the tube required to penetrate and the longer the exposure required. Perhaps it would be better to say the greater the density of the part, the greater the vacuum necessary in the tube and the greater the amount necessary to be passed through it.

4. The nearer the plate is to the tube the greater the object is magnified in the skiagraph.

5. Bones, needles, bullets and other objects in parts skiagraphed show sharper shadows the nearer they are to the plate. This frequently aids in determining the location of an object. Thus if a needle were imbedded in the hand and the picture was taken with the palm of the hand against the plate and the shadow of the needle was very sharp, it would be presumably nearer the palmar surface of the hand.

6. To secure the best results by excluding all but the direct rays, and to prevent motion in certain parts, as well as to secure enough pressure to render them more easily penetrated, a compression diaphragm is used. Various types of these are handled by different manufacturers.

7. If the plate and the object and the ray do

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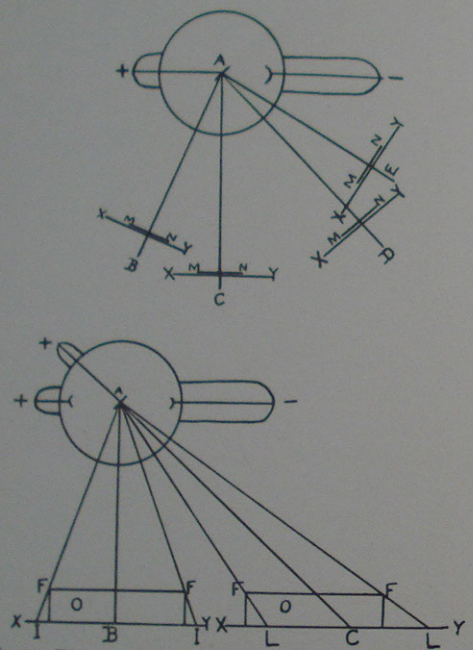

The Upper Figure Shows How to Place the Plate to Obtain a Proper Image. (See Page 91.) The Lower Illustration Shows How the Object O Is Magnified but Not Distorted if the Central Ray AB Is Perpendicular to the Center of O and XY. If the Ray (AC) Is Not Perpendicular the Points FF Appear at LL, Thus Producing a Distorted Image.

not possess a certain fixed relationship to one another, the image of the object will be distorted.

To Obtain a Proper Image. The necessary arrangement of part, plate and tube to prevent distortion is to have the object lying immediately in contact with the smooth side of the envelope containing the plate (their planes being parallel), and bearing such a relation to the tube that a line perpendicular to the center of the plate, and therefore likewise perpendicular to the object, will pass through the focal point on the target of the tube.

Thus in the following figure, A represents the point on the anti-cathode (target) where the rays are generated. AB, AC, AD, etc., represent single rays passing from the point A.

If a plate XY with an object MN be placed so that any one of the lines AB, AC, etc., is perpendicular to its center, then the resulting image will be in proper proportion. It will be more magnified the closer the plate is to the tube, but the various parts will always be in proportion.

If the plate is placed so that the shortest line from A is not perpendicular to it then distortion follows ammeter, a type of which is here shown.

Plates are developed in a manner similar to photographic plates. When examined the plates should be held with the coated side towards the operator, when the image will appear to you as if you were looking at the part from the point A on the target.

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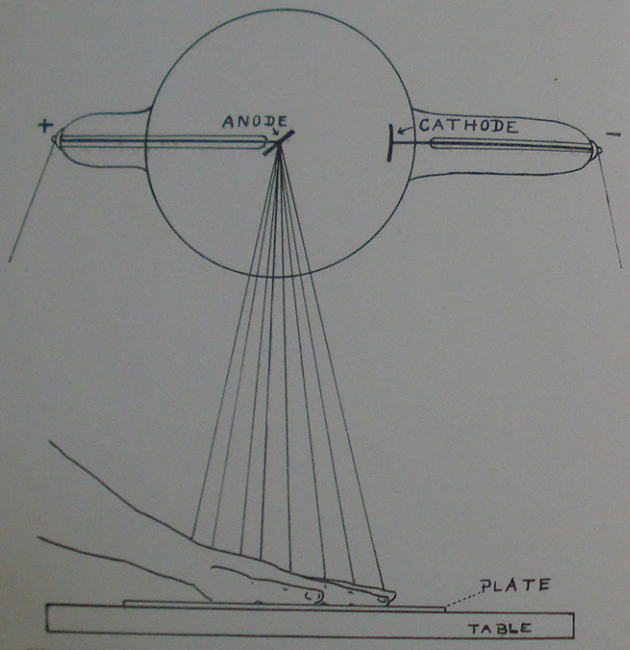

Illustrating Position of Tube, Plate and Hand in Making a Skiagraph.

Illuminating boxes add greatly to the distinguishing of details on the plate. Remember that it represents super-imposed or overlapping shadows.

Time of Exposure. No fixed rule can be laid down for the time of exposure as it varies with different forms and makes of apparatus and also from time to time with the same machine, depending, as it does, upon so many factors. The beginner is advised to make a few plates on his apparatus, exposing the same part two or three times with varying lengths of exposures, etc., and thus arrive at a definite idea of the time required with his own outfit.

The following table gives an approximate idea of the time to expose for the various parts of the body together with the distance from the tube to plate:

PART.	DISTANCE.	TIME.
Hand	12 to 18 in.	1 to 15 sec.
Wrist; Elbow; Fore-arm	18 in.	5 to 30 sec.
Shoulder	18 to 24 in.	10 sec. to 1¼ min.
Cervical Vertebræ	18 in.	10 to 30 sec.
Dorsal Vertebræ	18 to 24 in.	1 to 2 min.
Lumbar Vertebræ	18 to 24 in.	1 to 2 min.
Foot	15 to 18 in.	5 to 20 sec.
Ankle	15 to 20 in.	5 to 30 sec.
Knee and Leg	18 to 24 in.	10 to 60 sec.
Hip	20 to 30 in.	1 to 4 min.
Pelvis	24 to 30 in.	1 to 5 min.
Chest	24 to 30 in.	1 to 3 min.

The longer time is for the static machine or the small coil. Some machines are powerful enough to take instantaneous pictures of any portion of the body. Muscular subjects absorb more rays than those who are poorly developed and call for relatively longer exposures.

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tures.*—It is criminal negligence not to obtain a skiagraph in each case of dislocation or fracture, if it is possible to secure one. The value to the physician from a diagnostic point is apparent if after adjustment of fractured bones or reduction of a dislocation, the plate shows the result to be satisfactory. If not, it enables it to be made so, and also serves as a valuable record.

Value of the Skiagraph in Dislocations and Fractures.*—It is criminal negligence not to obtain a skiagraph in each case of dislocation or fracture, if it is possible to secure one. The value to the physician from a diagnostic point is apparent if after adjustment of fractured bones or reduction of a dislocation, the plate shows the result to be satisfactory. If not, it enables it to be made so, and also serves as a valuable record.

I have frequently uncovered grave mistakes in diagnosis by means of the radiograph; cases which would have justly merited mal-practice suits had they been allowed to remain.

The Skiagraph in Legal Practice.—In nearly all of the states skiagraphs are admitted in evidence provided they are properly introduced.

In order to make them competent, the attorney must show by his questions that the physician is versed in the taking of skiagraphs; that he personally made the one introduced in evidence; and that it correctly shows the condition of the part radiographed. The doctor may then state what the plate and print show.

To aid in identifying a skiagraph it is customary to place on the plate at the time it is exposed, lead letters giving date, number, and name of physician or laboratory, also letters R and L for right and left. The patient's name and the date may be scratched on the coated side of the plate after it is

developed, in the absence of lead letters, thus identifying it.

A record of the number, date, name, length of exposure, distance, kind of tube, etc., should be kept.

In legal cases it is often deemed advisable to take two plates at one exposure, one plate being placed over the other. This provides against an accident to one of the plates. Where the arm, shoulder, knee, etc., are involved, a skiagraph of the normal side is desirable for comparison.

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CHAPTER V

General Action of Ray—Action on Blood—On Glands—Leucotoxin—X-rays and Sterility—Sterilization of Criminals—Effect of Ray on Young Amphibians—Abortion Caused by X-ray and Effect on Pregnancy.

General Action.—The general action of the X-ray is finally destructive, a condition largely arrived at through interference with the reproductive power of the cell.

It brings about changes in both normal and abnormal tissues, the latter yielding first.

It is destructive to some forms of germ-life and inhibitive in its influence on other bacteria.

This result usually occurs as in the tubercle bacillus, by first greatly increasing the activity of the germs and ultimately producing attenuation from over-growth and inability to multiply.

This condition is accomplished in the living tissues, but has not been demonstrated in plate cultures, leaving the obvious conclusion that the ray stimulates the natural anti-toxic elements of the body (anti-bodies). In this connection a similarity is noted between the ray and vaccines and opsonins.

The X-ray contracts blood-vessels, especially the arterioles, even to the point of actually producing necrosis by shutting off the nutrition or blood-supply of the tissues. This is largely brought about by the increase in the cellular coat of the arterioles and corresponding diminuition in their caliber.

As the larger part of the rays are absorbed by the skin, it naturally follows that the principal evidences of the action of the ray are seen in the skin and these changes as shown by itching, redness, pigmentation, desquamation, blistering and ulcers are noted under the subject of dermatitis.

Additional changes from prolonged exposure are the formation of little horny excrescences (hyperkeratoses) on the skin which at times may become malignant.

Atrophy of sebaceous glands, hair-follicles, etc., with falling of hair or nails are other manifestations.

The skin often becomes covered with fine wrinkles from the destruction of epithelial elements and their replacement with connective tissue.

Action on the Blood.—Morris* has made an exhaustive study of the action of the X-ray upon the blood and I quote his conclusions in full:

1. The Roentgen rays cause a marked diminution in the absolute number of leucocytes in the peripheral circulation.

2. Preceding the leukopenia, there may be a moderate rise in the number of leucocytes from 8 to 12 hours after the exposure, the increase being due largely to the greater number of polynuclear cells in the circulation (observed only in the rab-

*American Medicine, Dec. 2, 1905.

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bit); the same condition may be found just at the end of the exposure, subsiding rapidly.

3. The lymphocytes are especially susceptible to the action of the rays; they are affected first and most intensely.

4. Alterations in the histologic characters of the lymphocytes and polynuclear amphophiles may be found in the rabbit, similar to those described in the lymphoid tissue and bone marrow.

5. Hard tubes produce the most marked changes in the leucocytes.

6. No noteworthy numeric or histologic alteration takes place in the red blood cells within the first few hours following exposure; the percentage of hemoglobin is not essentially affected within the same time.

The action on the blood has also been carefully studied in Romberg's clinic at Tübingen, by Helber and Linser.*

They observe that the rays exert a specially destructive or injurious action upon the leucocytes, without noticeably affecting the red corpuscles.

The whites are not only destroyed in the blood-forming organs, but in the circulation as well.

The lymphocytes are first to yield to the action of the ray and suffer most from it; thus coinciding with Morris' findings.

*Münchener Med. Wochenschrift, LII, April 11, 1905. Also Linser & Sick. Deutsche Archiv. f. Klin Med. LXXXIX, No. 5, (1907).

Leucotoxin.—Milchner & Wolff (Berliner Klin. Woch. XLIII No. 23) show by their researches the formation of a leucotoxin under the action of the ray.

Action on the Glands.—The lymphatics become smaller and there is a replacement of their structure with connective tissue.

Experiments carried on by Buschke and Schmidt† showed that the kidneys and testicles reacted differently under the ray.

In the testicles comparatively mild exposures produced atrophy without any apparent inflammatory reaction.

The kidneys resisted until subjected to very strong exposures, when a marked destructive process ensued.

Warthin* sums up the action of the rays on the kidneys as follows: (1) Half-hour exposures of small animals produce slight nuclear changes in the epithelium. This is recovered from, but is followed by albuminuria and cloudy swelling, which is proportioned to the degree of lymphoid destruction; (2) if animals are exposed until death occurs the renal cells will be found small and cloudy and tubules distended with an albuminous precipitate; (3) continuous exposure for five hours is fatal within ten days, death following paresis and coma, which symptoms

†Deutsche Med. Wochenschrift, XXXI, No. 18.
*N. Y. Med. Journ., May 25, 1907, quoted from Gibson's Abstract in Journ. Adv. Therapeutics, Sept., 1907.

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have a definite relation to the lymphoid destruction and the kidney lesion. The symptoms may imply injury to the central nervous system or auto-intoxication; (4) it follows that the destruction of leucocytes in the treatment of leukemia by X-rays may be injurious to the central nervous system or the kidneys. Hence, with prolonged and repeated irradiation of the lymph nodes and spleen in human beings, possible renal injury must be considered and repeated examination of urine made; (5) X-rays disturb the chromatin of all cells; the lymphoid cells and epithelial cells of the testes being most sensitive, the renal cells being less so. All cells capable of rapid proliferation or renewal are especially susceptible to X-ray influence."

The secretions of the sweat-glands are easily controlled or stopped by the ray without injury to skin or glands. This latter fact has been noted by most radiotherapists.

X-Rays and Sterility.—It has been conclusively proven that the ray has a destructive action upon both spermatozoa and ova and that continued exposures will produce sterility without other perceptible phenomena.

This is because the more embryonic in character the cells are, the more easily they are influenced by the ray, which exerts its primary physiological action on the reproductive element in any cell. Care

must therefore be used to protect the testes and ovaries from undue exposure to the rays.

This is best accomplished in the case of Roentgen operators by the wearing of a protective apron.

The serious effect of the rays in these cases I believe has been somewhat exaggerated. It was formerly believed that X-ray sterility was necessarily permanent, but now exceptions are known to exist.

Jordan (Brit. Med. Journ. Number 2427) believes that operators become sterile in a year or so even when using all of the customary protective devices (protected tubes, aprons, and keeping a few yards away from the tube).

Granger (Jour. Adv. Ther., Dec., 1907) cites cases of recovery from sterility after absence or protection from exposure.

This should not cause operators to become careless but that such recovery takes place I can personally testify.

Sterilization of Criminals and in Case of Certain Diseases.—The possibility of utilizing the destructive power of the rays upon the cellular elements of the testes and ovaries as a means of protecting society against certain individuals naturally suggests itself, if sterilization at will may be produced by the Roentgen ray. While theoretically possible to do this with the ray, I believe that vasectomy is a simpler and more certain method of producing sterilization.

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Effect of Roentgen Rays on Young Amphibians.* —Schmidt found that the rays inhibited the growth of young larvæ and interfered with the hatching of eggs. Axolotl eggs were exposed and the comparison with the control eggs of the same spawn went to show that the hatching was greatly interfered with and that where the animals did hatch, they died in a short time. The normal nervous tissue of brain and cord was almost entirely destroyed. Radium rays produced the same results.

Abortion Caused by X-Ray Exposures, and Effects on Pregnancy, etc.† — Fraenkel (Interstate Med. Journ. quoted in Journ. Clin. Med.) claims that the Roentgen ray retards the growth of the ovum and tends to produce abortion when the thyroid gland and ovaries are exposed to it. He cites one case in which he produced an abortion by twenty-five exposures of from 5 to 10 minutes each, the thyroid receiving a treatment every other day.

He also mentions interference with menstruation resulting when the thyroid was exposed in treating goiter.

I know of two cases where patients that were being treated for acne complained of delayed and scanty menstruation, which was supposed to have been produced by the ray. This might be due to

*From an abstract in Jour. Amer. Med. Assoc., Aug. 8th, 1908, p. 516.

†Articles on this same subject, in addition to those cited, are Ancel and Bouin, Presse Medicale, XV, No. 29, 1907. Specht, Archiv. f. Gynakologie, LXXVIII, No. 3, 1906.

exposure of the thyroid during the treatment of the acne and possibly indicates that we should protect the gland when treating in its vicinity.

On the contrary, however, I have treated many cases of goiter in which there was no deviation from their accustomed habit, either in quantity or in regularity of menstruation. The flow is frequently scanty in women affected with this disease.

Longfellner (Munchener Med. Wochenschrift, LIII, 1906, P. 44) experimented on guinea-pigs and claims that even short exposures had injurious effects upon the embryo in the gravid uterus and that prolonged exposures killed it.

Fellner and Neumann (Centralblatt fur Gynäkologie, XXX, P. 22, 1906) came to similar conclusions after experiments on pregnant rabbits and declare that the growth of the fetus is arrested and ovarian degeneration produced.

I do not believe the action of the ray to be so serious as to wholly contra-indicate the exposure of a pregnant woman to it under all circumstances.

Pusey (Jour. A. M. A., Dec. 8, 1906, p. 1933) refers to seven women who had numerous exposures previous to or during pregnancy; some receiving over 100 exposures, without any precaution taken to protect the ovaries, because no danger was known at that time. All seven had children within 18 months after stopping treatment and none aborted.

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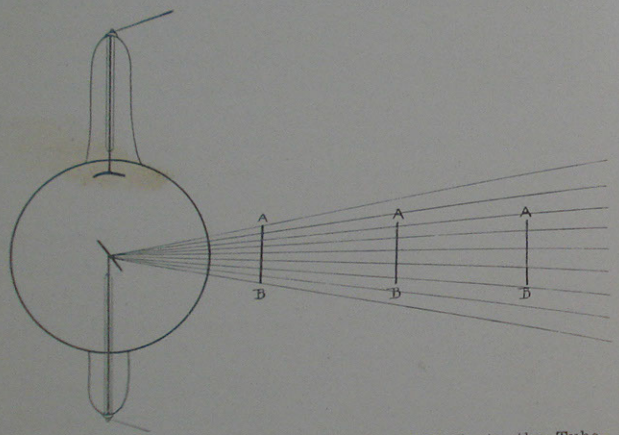

Illustrates How the Nearer the Object AB Is to the Tube the Greater the Number of Rays Falling Upon it; Therefore the Quicker the Reaction. See Page 106.

CHAPTER VI

Intensity of Rays—Williams Table—A Theory of the Absorption of the Rays—Dermatitis, the Pathological Manifestation of the Ray—Geyser's Theory—Visible Reaction not Always Necessary—Short Exposures More Easily Controlled—Dermatitis Solely a Question of Dosage—Forms of Dermatitis—Acute Dermatitis—Chronic Dermatitis—Belated Burns—Treatment of Dermatitis—Frequency of Dermatitis—Does the X-ray Produce Cancer?—Blondes More Susceptible—Factors Governing X-ray Exposures—Roentgen Ray vs Surgery—Post-operative Radiation—Production of Fluorescence in the Body.

Intensity of Rays.—In general terms, the intensity of the ray varies inversely as the square of the distance. Williams (Archives of Physiological Therapy, February, 1906) states that a medium tube backing up a 4-inch spark, placed with tube 10 inches from surface treated will produce redness in an average of 90 minutes and places the safety limits at about 62½ minutes. He gives the following valuable table showing the relative intensities of the ray at the several distances together with the safety limits:

Distance. Inches.	Relative Intensity.		Safety limits. Minutes.
2 1	1.000	25.00	2.5
4 ..... ¼	.250	6.25	10.0
6 ..... 1/9	.111	2.77	22.5
8 ..... 1/16	.062	1.56	40.0
10 ..... 1/25	.040	1.00	62.5
12 ..... 1/36	.027	.69	90.0
14 ..... 1/49	.020	.51	122.5
16 ..... 1/64	.015	.39	160.0
18 ..... 1/81	.012	.30	202.5
20 ..... 1/100	.010	.25	250.0

A Theory of the Absorption of the Rays.—It is universally agreed that in order to influence the

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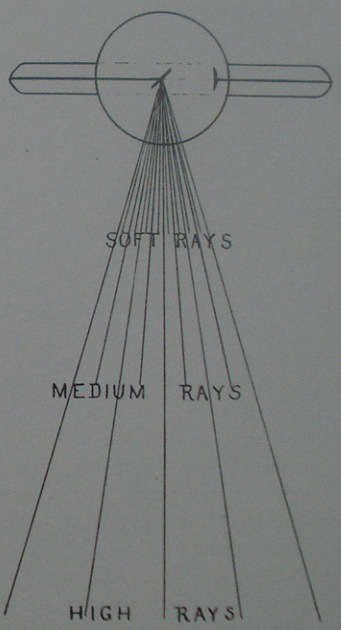
tissues, the rays must be absorbed. It is also agreed that low tubes produce quicker reactions than high ones, although the resulting dermatitis is not so deep-seated.

I have been accounting for this by comparing the ray to a rifle bullet. A bullet fired at close range possesses sufficient force to pass through a body without being ordinarily sufficiently interfered with to stop it and cause it to remain within the body. There comes a time, however, when the force of the bullet is largely spent, and if at that time it comes in contact with an object it does not possess sufficient impetus to pass through, but lodges within. So it is with the rays from the X-ray tube; the stronger rays pass through the surface treated and at the time when they have gone far enough to be easily arrested they are entirely without the body. Weaker rays are easily stopped when they have passed through a comparatively short distance.

Since the rays are generated at a point on the target and diverge in all directions from that point it is readily seen that the closer an object is to the target the greater the number of rays, both strong and weak, that will fall upon a given surface. Since the weaker rays are easily arrested they will be stopped and absorbed by the tissues at a short distance, while the higher rays will pass through and will not be greatly absorbed at all, while passing through the body.



Shows Relative Points Where Rays of Different Strength Are Easily Stopped and Absorbed, the Distance of Tube from Patient Being Regulated in Accordance with the Penetration of the Rays it Generates.

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In order to get absorption of the higher rays the surface treated would have to be far enough away to receive the rays at a point where most of their force was dissipated and they would therefore easily be stopped and absorbed by the tissues. (See Figure on Page 71.)

Dermatitis the Pathological Manifestation of the Ray.—In 1902 I suggested that the action of the ray should be compared to that of a medicine, where the first effects were considered as physiological, gradually increasing until the full physiological effect was manifested, then followed by the first symptoms of a pathological effect and finally by a thorough establishment of a pathological condition.

I have likened it to the action of strychnine, where the system feels its tonic and stimulating effect up to the point where every nerve is at the highest tension, marking the full physiological effect beyond which come the slight twitchings as forerunners of the toxic or pathological effect; later manifested by severe convulsions, etc.

To get results with the X-ray it has been considered necessary to produce a visible reaction in the form of a dermatitis before improvement could be expected. It may still be considered necessary as we have no means of knowing the exact dosage of the ray required to produce a full physiological action without passing the borderland into the pathological realm as evidenced by the dermatitis. The time is coming, however, when means of accurately

measuring and estimating the dosage will be discovered and then it will be possible to maintain the effect of the ray at or near its full physiological action and thus bring about the desired result without producing any visible evidence of injury from an over-dosage.

Geyser's Theory.—Geyser† believes the dermatitis results from the inductive influence which the current causes in the air between the patient and the tube, which he claims is overcome by placing the tube in direct contact with the area treated, as in the Cornell tube which he has devised.

Visible Reaction Not Always Necessary.—I have repeatedly demonstrated the possibility of producing a cure without visible reaction or with one so slight as to be essentially absent, but unfortunately have not been able to do so uniformly. It was obtaining results without perceptible reaction that gave me the idea of very short, but more frequent treatments.

Short Exposures More Easily Controlled.—I believe that the tissues can receive, appropriate and recover from a small dose of the rays in a comparatively short time, and permit of another small dose being administered soon; instead of one large dose that entirely overcomes the normal resistance of the

†Geyser, Jour. Amer. Med. Assoc., Mar. 28, 1908; also Amer. Jour. of Surgery, May, 1908, and Med. Times, Oct., 1908.

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Showing a Dermatitis or Reaction on the Mucous Membrane of the Upper Lip, Produced While Treating an Epithelioma. This Mild "Burn" Appeared at the Conclusion of the Treatment; the Epithelioma Which Involved the Whole Upper Lip Above the Mucous Membrane, Having Disappeared, the Dermatitis Healed in Three Weeks.

tissues, injuring healthy, normal parts as well as those diseased. It is like a twig that may be slightly bent an indefinite number of times and immediately springs back to its former position, but breaks in two when a single strong force is employed.

By small doses the action of the ray is under better control and can gradually be carried to the point where sufficient effect is obtained to overcome abnormal conditions without at the same time sacrificing the healthy tissues.

Dermatitis Solely a Question of Dosage.—From the previous paragraphs it will be seen that the production of dermatitis is entirely a question of dosage. The Roentgen ray is a powerful agent and must be used, therefore, with this thought in mind. Employed judiciously it is practically harmless, but carelessly handled it is disastrous alike to patient and operator.

Too long or too frequent exposures will result in an over-dose of the ray, which we call dermatitis.

Because harm follows an over-dose is certainly no reason why the ray should not be used at all. The fact that death follows an excessive dose of arsenic or strychnine certainly does not deter the physician from using these poisons in proper doses.

There are, however, so many factors entering into the production of the X-ray that its proper dosage is not yet as thoroughly understood as in the case of the drugs mentioned.

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Occasionally a patient proves to be unusually susceptible to the ray. In these instances if a dermatitis follows one or two average exposures for therapeutic purposes or one exposure for a skiagraph, the operator should be held entirely blameless.

If, however, an operator started to give daily treatments of 15 or 20 minutes each; or if he exposed a patient 3 or 4 times in succession on the same day for skiagraphic purposes, he should be held responsible if the resulting dermatitis becomes a serious one.

The same applies where he carelessly exposes a patient when symptoms of dermatitis are already present.

Forms of Dermatitis.*—X-ray burns may be considered under two general forms, acute and chronic, which may be further classified according to degree.

Acute Dermatitis.—The acute form comes in from 24 hours to as many days and occasionally after two or three months have elapsed. In a majority of cases it appears in six to ten days.

Usually redness is the first symptom to appear, accompanied by severe itching. Often the itching attracts attention before the erythema has been noticed. Pigmentation may precede or follow the reddening.

*For a more comprehensive consideration of the subject of dermatitis, the reader is referred to the following:
Burdick. Wisconsin Medical Recorder, May, 1906, and Medical Summary, July, 1907.
Kassabian. Text-book p. 398 et seq.
Codman. Phil. Med. Journal, Mar. 8 and 15, 1902.
Kienböck. Wiener Med. Presse, 1901; p. 874.
Freund. Text-book p. 337 et seq.

The condition is especially noticeable about the hair roots; the skin showing small red points surrounding the base of many or all of the hairs.

The itching has now become intense and the skin tumid and more or less swollen, and feels harsh, dry and leathery. At this time it may present a very glossy appearance.

In four or five days the bright red gives way to a dull, leaden, angry hue, and the hair also becomes dull, lusterless and brittle.

In mild cases the redness and inflammation gradually subside after a few days and may not be followed by desquamation. Hairs may or may not fall out at this time.

This might be called a dermatitis of the first degree.

In a more severe form, which may be termed the second degree, there will be the formation of blisters, with a serous exudate and marked neuralgic pain. This form is much slower in healing, often requiring weeks.

In severe cases the deeper layers of the skin and underlying tissues become involved, a tough slough forms, and the destructive condition shows a tendency to spread. The pain is a marked symptom in nearly every case, and resists all ordinary remedies.

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Chronic Dermatitis.—The chronic forms are usually found in X-ray operators, and almost always upon the hands.*

In these cases there is usually more or less redness and pigmentation; the nails become thin and brittle, so that in trying to open a knife-blade they bend or break. The nails and skin are dry and harsh and the nails frequently split lengthwise and are ridged in appearance. Later they may drop off. The hair on the back of the hand becomes thinner and frequently falls out. Tiny hard lumps form under the skin, taking on a somewhat warty appearance and frequently breaking down into chronic ulcers. A serous exudate is commonly present. The itching which accompanies some of the earlier symptoms may give way to a deadened or numbed sensation. Pain in the joints is usually present.

The skin becomes hard and between the leathery ridges are many fine wrinkles.

In occasional cases the ulcerative condition becomes progressive; or malignant disease takes hold under these favorable or predisposing conditions and amputation and finally death have occurred in a number of cases.

Allowing that there are 10,000 X-ray operators in the world to-day and that in ten years ten fatalities have been reported, the percentage is so small a

*The face and chest may also become involved.

part of 1 per cent that no great alarm need be felt so far as life is concerned.

Belated Burns.—The importance of remembering that a burn will occasionally make its appearance months after apparent immunity, must not be lost sight of. In treating patients where general radiation is required this must constantly be borne in mind. A necrosis may appear many months after treatment has been discontinued, which is really an X-ray gangrene resulting from the destruction of the blood-vessels supplying the part.

Treatment of Dermatitis.—Mild erythemas disappear in a little while without treatment.

In those cases where a crust has formed after a serous exudation, it should be let severely alone, as Nature has provided the best dressing known.

Applications of vaseline are especially irritating and so are carbolic and bi-chloride solutions and antiseptics in general.

No other application has given as much relief as normal salt solution. Obstinate chronic ulcers are apt to require curetting; and deep forms being essentially gangrene, should be treated as such by surgical removal.

The following combination is recommended by Mewborn in St. Louis Med. Review as giving prompt relief from X-ray burns:

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℞ Plumbi acetatis .....gr. c 6|65
Aquæ .....℥iiss 75|
Solve et adde:
Aluminis sulph .....℥i 4|
Sodii sulph .....gr. x |65
Aquæ .....℥iv 120|
M. Sig.: Apply locally to the affected areas.

I have recently made satisfactory use of carbon dioxide snow in removing the small, hard lumps found in the chronic dermatitis of operators.

Frequency of Dermatitis.—A number of operators have investigated the records to find in about what percentage of exposures, reasonably severe dermatitis develops.

Codman says the number is about one in 5,000. Kassabian reports three in 8,000 diagnostic exposures. Freund had three severe reactions in 11,808 exposures.

Does the X-Ray Produce Cancer?*—It seems to me very improbable that the X-ray is capable of primarily producing cancer. Since its first effect is to increase cell proliferation, it would naturally be inclined to stimulate the growth of latent cancer cells.

*To those who are interested in reading up both sides of this question, the following references are given: Hutchins. Jour. Amer. Med. Assoc., July 1, 1906, p. 15. Editorials in Jour. Amer. Med. Assoc., May 19, 1906, and March 21, 1908, and Semaine Medicale, XXVII, No. 49. Dec. 4, 1907. Wyss, Deutsche Zeitschrift f. Chirurgie, XCIII, No. 6, July, 1908. Oudin and Zimmern, Presse Medicale, XVI, No. 32 April 18, 1908. Schumann. Archiv. f. Klin. Chirurgie, LXXXIV, No. 2. Jayle, N. Y. Med. Jour., Feb. 13, 1908. Jour. Advanced Therap., April, 1908, p. 209.

Also, since it produces the changes in the skin that usually result from old age, especially hyperkeratoses, it thereby affords favorable conditions for the development of cancer. Oudin in commenting on this point calls attention to a certain factory where anthracene is much used and where these same hyperkeratoses appear on the hands of the workmen with frequent epitheliomatous degeneration. To produce such a result with the ray implies a prolonged and, in view of our present knowledge, a careless use of it, such as would not be likely to happen in treating patients.

In giving upwards of thirty thousand X-ray exposures I have never seen a benign case change into a cancerous one under its use.

The fact that a few X-ray workers who suffered from chronic dermatitis developed cancer in this excellent soil, and died from it, really proves nothing. Of ten thousand workers in any line it would be probably possible to find in ten years a dozen who had developed cancer and we would not think of blaming their occupation for it.

To imbue the public with the belief that one or a dozen therapeutic exposures of the ray will produce cancer is certainly unwarranted by any facts at present in our possession.

Anent this subject, Dieffenbach in the Medical Record, March 27, 1909, states: "Neoplasms are due to interference with normal cell reproduction

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induced through trauma, pressure, severe inflammations, or constant irritations; these factors act on cell proliferation by producing abnormal cells, which, in turn, if the original irritating status is maintained, again generate cells of their own kind.

"If trophic nerve impulses are not interfered with, normal conditions may supervene when the irritation or inflammation subsides.

"If involvement of the trophic nerve takes place so that efferent and afferent impulses are interfered with or inhibited, riotous development of the new progeny of cells will be invited. If the trophic nerve supplying the part is severed or permanently inhibited, ulceration will supervene."

Blondes More Susceptible to the X-Ray.—As would naturally be expected blondes react much quicker to the rays than brunettes. They also recover quicker from the unpleasant effects. Blonde X-ray operators also show less serious permanent effects than those of the darker type. In giving treatments the complexion should be taken into consideration. About one-fourth less time length of exposure for blondes than for brunettes will give the same results. I have seen redness and peeling of the skin follow two five-minute exposures 48 hours apart, in a very pronounced blonde.

Factors to Be Considered in the Application of the X-Ray.—Freund* considers the results of X-ray

*Text-book, p. 243.

exposures to depend on the following factors:

1. Strength of primary currents.
2. Capacity of coil.
3. Intensity of rays and vacuum of tube.
4. Duration and frequency of sittings.
5. Distance of tube from patient.
6. Susceptibility of tissues.

Roentgen Ray vs. Surgery.—Elsewhere in this book, under carcinoma, sarcoma and tuberculous glands, this subject will be found further discussed. As the author practically limited his work to surgery before taking up the X-ray, he believes himself capable of judging fairly on both sides of the question. This is contrary to rule, as most surgeons know very little about the ray, and Roentgen operators are seldom competent surgeons, therefore these two classs have often clashed when they should really work in harmony. The common field is especially in malignant diseases and in tuberculosis of glands, joints, etc.

The value of surgery has been thoroughly established, but that of roentgentherapy is not known nearly so well. A careful examination of facts will convince the most skeptical that the ray has accomplished results that compare favorably with surgery.

It then becomes really a question of choice in many cases, while in others the two measures should be combined, one insuring the effectiveness of the other.

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It must be borne in mind always that by surgical means we can **immediately** remove an area that it will take some time to influence with the ray; therefore, if the case is urgent, surgery must be given the preference.

On the other hand, owing to the fact that in many instances recurrences follow surgical interference on account of the overlooking of small foci, it becomes **equally imperative** to follow up the operation with the ray, because it can penetrate the tissues and destroy these minute foci, and there is no time so suitable as immediately after operation, when the amount of malignant material is reduced to the minimum.

Where a case is not spreading rapidly, it is usually possible and desirable to subject the case to the ray first, and thus an operation may be avoided. The cosmetic results are better following the ray. If the malignant disease shows signs of spreading, or involving glandular tissue, or in the case of tuberculous glands if the latter break down, operation should be resorted to at once, followed by more X-ray.

In inoperable cases, the ray becomes the only method available. Frequently though, in these cases, it is desirable to remove as much as possible by operation before employing the ray.

There are plenty of cases on record where recurrences after operation have been successfully treated with the Roentgen ray.

Post-Operative Radiation.—Much that is said under this heading must be a repetition of the statements made in the preceding section. It is important to emphasize a few points:

1. To neglect to follow up an operation with the ray in a disease where recurrence is possible, is **criminal negligence**, and deprives the patient of a valuable treatment that will ordinarily prevent a return of the disease.
2. Do not wait for the recurrence to take place.
3. The best time to treat must be when the foci are necessarily small.
4. Roentgenize not only the area operated on but also include that containing the draining lymphatics.
5. Be sure that you keep it up until you have given a sufficient dose of the ray. A quarter dose or half dose is worse than no X-ray at all, and undoubtedly accounts for a percentage of failures. It may even stimulate new tissue growths.*

The Production of Fluorescence in the Human Body.—This idea originated with Dr. W. J. Morton.† The principle involved in a saturation of the body or part of it with a medicine which will fluoresce when acted upon by the X-ray or radium emanations.

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*Boggs expresses this opinion in Annals of Surgery, Feb., 1908.

†Paper read before a section in Electro-Therapeutics, International Elec. Congress, St. Louis, 1904. Also N. Y. Med. Journ., Feb. 13 and 20, 1904, and Med. Record, Aug. 8, 1903.

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If the patient, therefore, is exposed to the X-ray after taking one of these fluorescent remedies, the result is a development of light within the tissues and the therapeutic benefit that naturally would result. For this purpose bi-sulphate of quinine in doses from 5 to 15 grains a day; fluorescin, 6 to 20 drops of a 1 to 30 aqueous solution three times a day, an hour after meals; or esculin 5 to 15 grains a day, are three of the principal substances employed. X-ray exposures are made in the ordinary manner and are presumably enhanced by the fluorescence.

CHAPTER VII

Protective Measures—Protection of Patient—Shields, Masks, etc.—Protection of Operator—Methods of Various Operators—General Considerations.

Protection of Patient and Operator.—The importance of protecting the patient from unnecessary exposure to the action of the X-ray was early recognized and various methods adopted.

It is only comparatively recently, however, that the profession has arrived at a full realization of the great importance of protecting the X-ray operator.

For this reason I am giving this subject more space and consideration than would at first appear necessary.

Protection of Patient.—The method of protecting the patient most commonly in use has been the employment of sheet-lead or tin-foil to cover the parts contiguous to those under treatment.

Various devices have been contrived for preparing these shields.

I have found sheet-lead about 1-32-inch thick the most satisfactory.

Many have simply used the lead without any covering, merely cutting holes to permit of the rays reaching an affected surface. In this case a stinging sensation is occasionally felt by the patient as a result of the lead being within the electro-static field

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of the current and thus receiving a mild charge of electricity. This pricking sensation is not present if there is actual electrical contact or if the shield is insulated beyond the sparking distance of the charge on the lead.

Pusey* covers the masks on both sides with common wrapping paper.

Schiff and Freund† cover them with blotting paper.

Kienböck, Zeisler and others use flannel coverings.

Monell‡ used lead-foil lined with linen and also mentions the use of ordinary pasteboard masks, covered on the outside with tin-foil except over the area to be treated.

I have found it convenient to have various masks containing apertures of different sizes. Also in treating acne, before I used a tube-shield I contrived various shaped caps for the head and used a pair of old spectacle frames wrapped with rubber (for insulation) and covered with sheet-lead cut to extend high enough to protect eye-brows as well as eyes.

I would now suggest for that purpose lead-glass mounted in rubber frames.||

Got§ uses an entirely different method, by first

*Text-book p. 327.
†Wiener Med. Wochenschrift, 1898, XLVIII, pp. 1057, 1119.
‡Text-book pp. 71-75.
||Rubber-framed glasses are now on the market.
§Archives d'Electricité Medicale, Feb. 25, 1906. Abstract in Archives Physiological Therapy, June, 1906.

taking a wax cast of the part to be treated with dental wax. I quote the abstract:

"This substance softens easily when placed in warm water, and remains soft enough if transported to the region by means of a wet and warm cloth. It hardens quickly by simply cooling, which may be accelerated by the use of a cold, wet towel. After the cast has been made, its outer surface receives a coating of a paste made by mixing equal parts of powdered lead carbonate and plaster of paris; this

Lead Glass Spectacles.

mixture is diluted with half its weight of water. The coating must be uniformly thick (about one centimeter). A rod may be attached to the cast while the latter is still wet, and may be later adjusted on any kind of a support.

"In order to cut in the cast an aperture corresponding exactly in size and shape to the affected part, the operator draws the same first on a sheet of paper and cuts it out. Then, after wetting it, the paper is applied on the part and when it is adherent, the outer surface is slightly coated with mucilage, the cast is applied on the part and the paper comes off glued inside the cast. Nothing remains to be done but to cut out the corresponding part of the

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cast, preferably beveling the edges. When it becomes necessary to modify the shape or the dimension of the hole, the former hole is first obdurated with the same paste and a new hole cut out."

Aluminum shields, first suggested by Thompson, have been used to reduce the effect of the rays upon the skin as they shut out the mildest rays while not interfering in any way with the passage of the higher rays.

Von Jaksch uses a shield made of a sheet of silver .02 of a millimeter thick and covered by cellulose. This is placed over the area exposed and protects the skin without preventing the influence of the rays on deeper structures.

Various ointments containing substances opaque to the X-rays have been used. Bismuth subnitrate with diachylon ointment is a favorite form.

Pfahler* uses a leather over the aperture of his shield, which he calls a "Roentgen Ray Filter." It is a disk of sole-leather five inches in diameter and about four times the thickness of the human skin. It effectually protects the skin from the soft rays, which are injurious to it.

A very convenient method, both for physician and patient, and mutually protective, is the use of some means to shut out the rays emanating from the tube except through a small aperture or window.

This was first accomplished by Williams, who

*Archives Physiological Therapy, Nov., 1905.

placed the tube in a box, covered inside with several layers of lead-paint, with a suitable arrangement of a sheet-lead diaphragm for regulating the size of the window through which the rays were allowed to emerge.

Many other boxes, usually lined with sheet-lead, have been devised.

As all of these methods have as much bearing upon the protection of the operator as of the patient, they will be described under that head.

Protection of Operator.—The serious results occasioned by continual exposure to the X-rays, however slight in intensity, have caused the profession to carefully consider methods of thoroughly protecting the operator.

The effects on the operator have included not only mild chronic dermatitis with changes in nails, hair-follicles, etc., but have extended to severe and unhealing chronic ulcers on the fingers or hands; horny growths (keratoses) which occasionally become malignant; and in a number of cases the amputation of fingers, hand or arm has been necessitated; whilst in a few cases life itself has finally been sacrificed.

It is true that the number of fatalities in comparison to the number of operators would amount to a very small fraction of 1 per cent, and most of these resulted from burns that first occurred before the seriousness of their effect was known and before protection was considered vitally essential; still, all of

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these facts point to but one conclusion. The operator must BEWARE, and must take all reasonable precautions for protecting himself.

In this connection it is well to state that institutions should be required to provide adequate protection for those employes that are engaged in radiotheraputic work.

Kirchberg* calls attention to this in a recent article.

Lead-masks; lead-protected gloves and aprons and similar devices have been used for the protection of the operator. Some very ingenious closets, etc., have also been contrived.

Lead-glass has been produced which will effectually cut off the X-rays and a convenient form of protection is a large sheet of this, mounted in a frame, behind which the operator may stand while the tube is in operation.

Freund† considers any one of the various tube-enclosing shields satisfactory.

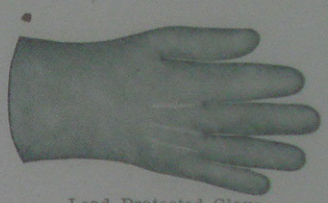
One of the most simple and convenient tube-shields is shown in the illustration on page 129.

The shield is secured in place by means of tapes.

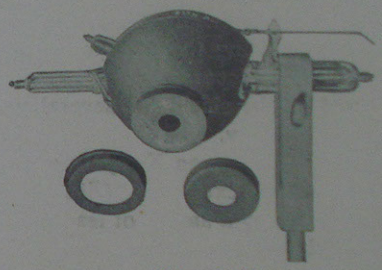
The whole active hemisphere is surrounded by the shield, which is made of a composition impervious to the rays.

Opposite the target, at an angle of 45 degrees from

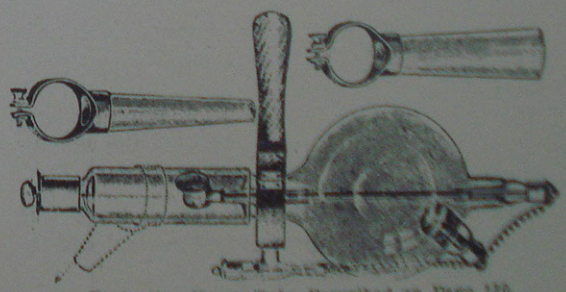
*Abstract in Archives Physiolog. Therapy, May, 1906, p. 258.
†Archives of the Roentgen Ray, April, 1906.



Lead Protected Glove.



Tube Shield.



Protective X-ray Tube Described on Page 130.

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the plane of the target, is a projecting collar surrounding a window three inches in diameter.

Through this aperture the rays pass when the tube is in operation.

A number of attachments accompany it by which the size of this opening may be diminished down to about ¾ of an inch in diameter and also two or three tubes are provided to fit into these diaphragms for the purpose of enabling the operator to direct the rays upon a particular spot or within a cavity.

I have used a tube shield for several years and find it very satisfactory.

Liebermann* describes an X-ray tube made with the anode in a tubular extension. (See illustration.) This is surrounded by a sheath of lead-glass, which shuts out all the X-rays except those which pass through a round window in the sheath placed opposite the anode.

Fitting over this window are various sized lead-glass specula, which direct the rays to the part to be treated.

It is stated that tests with photographic plates show no rays emerging except through the window or speculum.

Pfahler's Methods.—Pfahler† uses a large lead disk with side pieces to protect both patient and operator in connection with his leather filter.

*N. Y. Med. Journal, Oct. 21, 1905.
†Archives Physiological Therapy, Nov., 1905.

He says: "The original design consisted of a lead disk 18 inches in diameter, with a central opening of five inches, covered by variable diaphragms. This disk is then attached to a heavy iron stand which allows any needed change in height, angle or position of the diaphragms. To this primary device is now added either one or two side shields of lead. These are attached by an ordinary spring clamp, and can be moved about the edge of the disk so as not to interfere with the wires leading to the tube and yet so as to give protection to the patient and the operator. They are made four inches in height so as to cover the anti-cathode, and yet allow a part of the hemisphere of phosphorescence to be visible."

Pfahler† has recently contrived a penetrometer, which consists of a tapering tin tube 28 inches long, 3¾ inches in diameter at the longer end and 1 inch at the smaller.

On the side of the larger end is a Benoist scale backed by a small fluorescent screen and internal to this at an angle of 45 degrees is a mirror to reflect the shadow shown on the screen by the scale.

This can be used while the tube is in operation and through its ingenious arrangement the operator is thoroughly protected while testing the penetration of the tube.

A diagrammatic illustration is shown.

Bergonie in a communication to the Academie des Sciences, Paris, June 5, 1905, described a method of

†Archives Physiog. Therapy, June, 1906.

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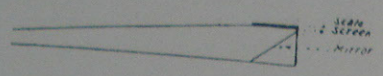

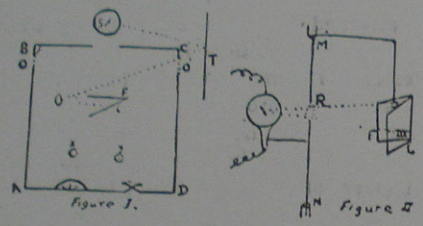

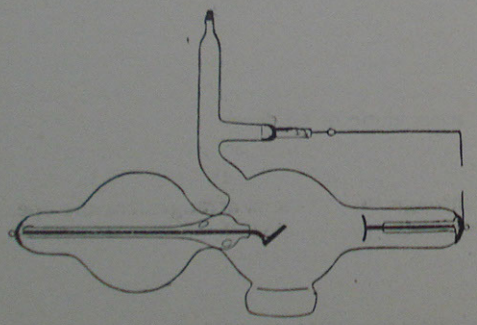

Upper Figure Shows Diagram of Pfahler's Penetrometer. Figures I and II Illustrate Cooper's Device (Page 137). The Lower Illustration Shows Pfahler's Safety Tube (Page 137).

protecting the operator by keeping him above the plane of the anti-cathode, while the patient is below that plane. He accomplishes it by having the table or couch on which the patient is placed, very near to the floor.

Method in Use in Von Strumpell's Clinic.—Krause (Münch. Med. Woch. LIII, No. 36) describes the methods in use in Von Strümpell's Clinic in Breslau:

"The individual operating the Roentgen apparatus stands in a wooden cabinet, 186 cm. tall, 126 cm. long and 106 cm. wide (about 6 feet tall, 50 inches long and 42 inches wide), coated on the outside with thick sheets of lead covered with waxed cloth to prevent contact with the lead. The tubes are inspected through two small windows of lead glass, 6 by 8 cm. (2½ by 3 inches). The cabinet has room for the interrupter and the condenser, etc., and for a chair. The box with the diaphragm is lined with lead, and for nearly three years a very large one has been used, 52x54x95 cm. (21x22x28 inches), which holds the largest sized tubes. The diaphragm box can be easily raised or lowered, and an observation window of lead glass at the back has a shutter to cover it. The box not only protects against injury from the rays, but it insures complete darkness for the ray illumination. The examiner wears an ulster and mittens made of lead-impregnated rubber stuff, and goggles of lead glass, or the fluorescent screen is covered with a sheet of lead glass. Lead aprons to

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protect the genital organs are recommended, but are seldom used. The patient is protected with two sheets of lead foil sewed into waxed cloth or washable rubber cloth. Pigmentation of the exposed skin has been prevented in his experience by interposition of a shirt, or a piece of thin parchment or silk paper. In order to prevent lead intoxication he is very careful to see that everything containing lead is scrupulously covered with impermeable material, waxed cloth or the like. The German law holds the chief responsible for injury sustained by his assistant or subordinates in Roentgen work as well as by the patient."

Leonard's Method.—Leonard* uses an ingenious, though simple, contrivance with a pasteboard box. It is cheap and can easily be made by anyone.

He says: "A pasteboard box three-eighths or one-half inch wider than the diameter of the tube is cut at the ends to admit the tube. There is a round opening through which the prolongation of the cathode end can extend and another at the anode end, which can be reached by a cut through the intervening pasteboard. The box is suspended from the ends of the tube and surrounds only the bulb. It can be held in place by rubber bands or cord.

"This box is covered with X-ray foil, a heavier lead foil than the ordinary tea lead.

"It is only necessary to cover the irradiated portion of the box, i. e., the luminous hemisphere of the tube. The lead surrounds the box and extends two inches below the bottom in flexible curtains, that can be so adjusted that the irradiated field can be limited to any extent. It is not necessary to cover the anode end or that portion of the sides behind the plane of the anode. At the cathode end, the lead must be cut away, one and one-half inches from the cathode prolongation, where it passes through the box. Where the lead hangs below the bottom of the box it is cut at the corners and thus forms three flexible curtains. The bottom of the box is removed so that in adjusting it the operator, by looking over the anode, can limit the irradiated field to any desired area by bending the lead curtains in or out.

"During all treatments, the patient lies in comfort on a couch, while the tube is held, on a bracket, over the portion of the body to be treated. The lead shield cuts off the rays from all but the field of operation. Where a small area is to be treated, all but this area may be covered by a small contact shield, while the remaining rays are cut off by the box. It is generally better to treat a considerable area surrounding the actual lesion, and it is seldom necessary to use any protection other than the lead covered box. This always protects the operator.

"The chief value of the box shield to the operator is that it protects him as well as his patient. It is simple, readily adjusted, efficient and always inter-

*Jour. Amer. Med. Assoc., May 6, 1905.

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posed between the operator and the source of Roentgen rays and of injury."

Piffard's Method.—Piffard* speaks of the Friedlander shield and also of one of German manufacture of heavy lead-glass.

He makes a satisfactory shield by coating his X-ray tube with twenty or more coats of lead-paint, leaving an opening two inches in diameter opposite the target. This coating is carried back an inch or so behind the plane of the target.

He says: "Naturally the ideal tube for safety would be one made of glass, having a high refractive index with a suitable window in it of glass with low refractive index; in other words, the main bulb of lead-glass and window of soda-glass. There appears, however, to be some insurmountable difficulty in making tubes of the larger sizes (six- and seven-inch tubes), such as are commonly used in this country for radiography and therapy. Bulbs of four-inch diameter can be readily obtained and two such may be joined as in the therapeutical tube for the treatment of dermal lesions as described.

"It is, of course, understood that such a tube is not adapted to the treatment of deep lesions or for radiography. For its intended purpose it should be actuated by a current of moderate intensity, and maintained at low vacuum, most readily secured by some form of automatic regulation. Non-radiable

*N. Y. Med. Journal, Jan. 6, 1906.

glass extensions can be attached to the main tube for the treatment of lesions in cavities."

This tube, which is known as Piffard's Safety Tube, is shown in the illustration. It has been recently somewhat modified in accordance with Dr. Piffard's ideas, so as to make it of great practical value.

Piffard uses gloves for hand protection made of "driving gauntlets that were well worn and flexible," which he covered with six layers of white-lead paint.

Cooper's Method.—Cooper* has constructed an elaborate closet or lead-lined, hinged wooden frame, with ingenious devices by means of lead-glass windows and mirrors, etc., so that the operator can observe patient and tube and yet be absolutely protected and also by which fluoroscopic examinations may be made with perfect safety.

It is thus described: "Figure I—A, B, C, D—represents a lead-lined wooden frame hinged at B. To the wall A D is attached the current plug and the rheostat: X and Y represent two handles which hang from above, by means of which two multiple spark-gaps attached to the coil can be controlled. O and Q are two small windows of heavy lead-glass. Through O the patient and the tube can be watched.

"Figure II represents a middle vertical section of the front B C. M N is a lead-lined board balanced

*American Medicine, Dec. 16, 1905.

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by a system of weights and pulleys. It carries the tube by an outside arm and the fluoroscope by an inside arm, as shown in the figure. At R is a circle of six inches in diameter, which can be diminished at will. The anode of the tube, the center of the circle, and the center of the fluoroscope can be adjusted to occupy the same straight line. They, then, together, can be readily raised or lowered. This gives us a vertical orthodiagraphic effect. The lateral movement of the patient gives us a transverse orthodiagraphic effect. To the fluoroscope F is hinged a mirror L at an angle of 45°. The observer stands entirely outside of the primary ray beam 1-2-3, and watches the reflected shadows in the mirror. He is even then subjected to the secondary rays emitted by the patient's body, etc., but these are trivial compared to the primary beam. The view obtained is satisfactory and the pulsations of aneurisms and the movements of the diaphragm can be clearly seen. The leaden lining is metallically connected with the gas pipe, so as to conduct away the induced electric currents.

"A just criticism of such a scheme as this would be that it presupposes much knowledge as to the appearance of Roentgen ray tubes of different vacuums when energized. This necessary knowledge can be acquired in a way readily understood by referring to Figure I.

"T is a mirror so placed that the reflection from

Lead Screen with Lead Glass Window for Operator's Protection.

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the tube S can be seen by looking through the window Q. Its penetrating power can at the same time be gauged by interposing various structures, e. g., movable aluminum plates between the tube and the fluoroscope; by means of the spark-gap the appearance of the tube and the ray penetration can be varied at will and mentally correlated.

General Considerations.—Holding uses a lead partition between the patient and the operator, made of two layers of sheet-lead 1-32-inch thick in a strong oak frame.

It is about 3x6 feet, with a mirror on a swivel so that patient and tube may be observed.

He also places the switchboard on the side of the room farthest from the X-ray apparatus.

A lead-glass window in the screen would, I think, be handier than the mirror.

In fact, a lead-screen with removable panels extending down the center, the size of a fluoroscopic screen, with one pane of lead-glass, would make a very satisfactory protector. A panel could be removed and the lead-glass window inserted at any desired height.* Then, if a fluoroscopic examination were required, the fluoroscopic screen backed by a lead-glass plate could be inserted in place of one of the panels.

All lead-glass shields in screen form are also on the market, as well as suits made of rubber containing a solution of lead-foil, and specially vulcanized so as to be pliable.

*Several manufacturers are now supplying similar screens.

In concluding this subject to which I have tried to give careful consideration, with a thorough review of the current literature on it, I would say that in general radio-therapeutic work the use of a tube-shield or safety-tube would ordinarily be sufficient protection.

In fluoroscopic work, a bario-platinum screen backed by lead glass, with a lead sheath to enclose the handle, or a protective glove would be sufficient for the average operator.

A protective apron would be a useful addition to the foregoing.

Several new protective fluoroscopes are on the market, nearly all of them taking advantage of the reflection shown by a mirror placed at an angle of 45 degrees.

For the constant worker with fluoroscopic and skiagraphic work a screen shield to stand behind is advisable.

I have observed two things:

1. The parts of the body covered with clothing usually show no trace of X-ray influence when the hands are badly affected, although these parts may be involved by extension, when malignant growths have grafted themselves upon X-ray dermatoses.

2. The operators suffering from severe burns are those who obtained them before any special protec-

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tion was thought necessary and not so much those who have used reasonable precautions from the start.

I have made a calculation of the average daily amount of time in which the operator is exposed to the ray when no protection is used.

This I would place at not less than five hours per day for those busy operators who have contracted severe chronic burns.

Even in these cases it has taken 3 to 5 years for these to develop.

The average operator who keeps back of the active hemisphere; who nearly always takes a plate rather than use the fluoroscope; or who uses any one of the simple protective devices, could scarcely average over 10 minutes a day of actual deleterious exposure to the rays. This would allow for an occasional unprotected fluoroscopic examination and for the momentary occasional exposure in starting or turning off apparatus before getting out of the area covered by the rays or in passing in front of the excited tube.

This would be about 1-30 of the actual exposure undergone in the other cases and if figured at the same rate would require 90 to 150 years to produce the same deleterious results.

Between these two extremes there is a wide margin which would indicate that reasonable precaution from the start, would make it unlikely that the operator would be affected during his natural life-time.

Exceptions would fairly come in the same class with patients who acquire a burn from a 5 or 10 minutes' exposure owing to personal idiosyncrasies.

This statement is not made to make operators careless, but to show that serious or fatal results need not follow if simple and easy precautions are taken and a little common-sense is used.

The operators who must be careful are those who have already developed severe cases of dermatitis from the ray, and cannot afford to take the slightest additional chance of increasing the trouble.

In some cases where death finally resulted, the operators persisted in exposing themselves after their condition even had become serious enough to call for amputation of fingers or hand; so great was their enthusiasm for the work.

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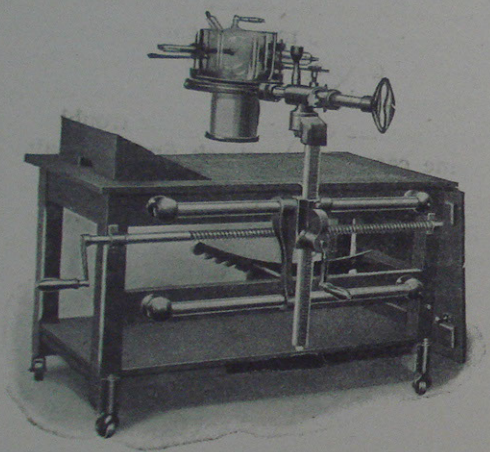

Compression Diaphragm and Table. See Page 89.

CHAPTER VIII.

General Technique—Personal Equation—Schiff and Freund's Technique—Kienböck's Technique—Burdick's Technique—Pusey's Technique—Author's Technique—Management of Apparatus.

Personal Equation.—There are nearly as many different techniques as there are operators; in fact, it is not long before the physician naturally formulates his own method. This brings us to the vital point that the personal equation is the most important factor in all electro-therapeutic work.

We find men using widely different methods accomplishing essentially the same percentage of cures; therefore, I maintain that it is not so much the particular technique employed as it is how thoroughly the operator has become a master of that method.

In a general way, the tissues appropriate and respond to about so many minutes of actual treatment, there being a considerable margin between the necessary dose and that amount of ray which would be absolutely injurious, thus affording reasonable latitude for the exercise of individual judgment and accounting for the fact that results have been obtained by widely differing techniques.

Whether short and frequent treatments are given, or whether comparatively long exposures are made with a considerable interval intervening, the results

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will be approximately the same number of minutes of exposure; while the character of vacuum maintained in the tube may be so offset by the distance from the surface treated that the final result will be essentially the same.

I give, herewith, a resume of the general technique employed by several operators, regretting that space will not permit including many others.

Schiff and Freund's Technique.—In his textbook on radio-therapy Freund gives the technique so successfully employed by Schiff and himself. In order to avoid any untoward results that might follow from individual peculiarities of the patient, he suggests one, two or three trial sittings of 15 minutes each with a medium tube at a distance of 20 cm. (8 inches) and then waits three weeks for any reaction.

The further technique is: "A Ruhmkorff's coil (30 cm.), is worked either from the main or from a 6-cell accumulator, the current being between 1½ and 2 amperes, and the interruptions averaging 16 per second. The tube is hard, yet one giving a good greenish flare.

"The tube must be so placed that the most intense rays proceeding from the anti-cathode strike the center of the region to be exposed. It has been shown elsewhere how the region of most intense radiation may be discovered.

"The distance of the tube from the skin is at first 15 cm. (6 inches), but this is afterwards gradually

decreased to 5 cm. (2 inches). In like manner the sittings are gradually prolonged from 5 to 10 minutes, and the part is irradiated until signs of reaction occur, when operations are suspended. The author has found the following early signs of reaction in by far the greater number of his cases treated as above described:

1. Intumescence of the skin.
2. Pigmentary changes.
3. Erythema.
4. Loosening of the hair.
5. Subjective symptoms.

"The intumescence is an early sign which is nearly always to be observed. A cheek, for example, which is being treated for hypertrichosis, appears after about three weeks fuller and rounder than the other; the skin appears tenser, a little oilier and perhaps more shining. At this stage no alteration in the color of the skin can usually be observed. Indeed, at first the changes are not very striking and they may readily escape the notice of an inexperienced operator. They are, however, noticed by the patients themselves, who usually scrutinize their skins most assiduously; they come, therefore, to the practitioner saying that the treatment does them a lot of good, and that they 'look much better than before.' In cases where the sittings are prolonged for some time the intumescence is, of course, longer maintained, whereby scars and irregularities in the skin

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surface are temporarily leveled, and the general appearance of the integument improved. The intumescence disappears after the sittings are suspended, but often a more lasting cosmetic effect is gained through the resulting desquamation. It must be noted that the intumescence is never sharply circumscribed, but rather diffuse; its border cannot be exactly defined. Finally, the sense of touch is not so useful in discovering its presence as that of sight. The alterations noticeable by palpation of an irradiated skin are almost imperceptible."

Kienbock's Technique.—"An adjustable Roentgen-tube whose vacuum has been brought to the 'soft' or 'medium-soft' stage is worked by means of a primary current of 3-6 amperes, the interruptions being secured through a turbine apparatus at the rate of 15-20 per second. The tube must give rays capable of penetrating the thorax of an adult at a distance of 1-2 meter. This tube is fixed about 20 cm. from the skin, and from 3 to 5 sittings of 10 to 15 minutes each are given on succeeding days. The sittings are then suspended for two or three weeks so that the reaction may develop. After all reaction has subsided the sittings are resumed as before."

Burdick's Technique.—In a personal communication, Dr. G. G. Burdick gives the following general technique:

"For infectious skin diseases, use a very low tube

of about one inch air resistance; one milliampere of current; for 10 minutes every other day. Tube distance from glass eight inches. Watch carefully for follicular inflammation and stop on its appearance.

"A new tube should always be used in this class of cases. With a coil no special protection is required. With a static machine pass ray through a grounded screen of thin aluminum foil. Aim to secure a severe dermatitis.

"For carcinomata use a medium tube that has been seasoned, about 14 inches from glass walls to skin. Use one milliampere of current for 15 minutes daily, for 10 days, and then every other day as a general proposition.

"It is better to avoid irritation. Slow, persistent radiation gradually does the work.

"The deeper the cancer, the farther away the tube should be placed; and occasionally much better results can be had with a new tube, passing the ray through a wet folded towel or similar filter.

"This insures freedom from burns and allows the use of a good deal more ray.

"The aim should be to get just enough penetration to reach the tumor.

"For sarcoma and tuberculosis of deep structures use an old well-plated tube. Expose every other day with tube distance of 12 inches from glass.

"Ray persistently for months and by all means

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avoid irritation. Slow persistent radiation gradually causes a change to take place in the tumor or diseased joint; and it is generally favorable to the patient.

"The higher and older a tube may be the more generally useful it will be found for this trouble."

Pusey's Technique.—Dr. W. A. Pusey's technique consists essentially in giving weak exposures and repeating them frequently so that the X-ray effects gradually accumulate.

For superficial lesions like acne and psoriasis he uses a soft or medium tube with very mild exposures. His standard exposures for such conditions are of five minutes' duration with the tube at a distance of six inches for small areas, at a greater distance and a longer time for large areas.

For circumscribed superficial lesions like epitheliomata where he wishes to get a prompt effect he gives exposures of fifteen minutes' duration at six inches distance and with a greater amount of X-rays.

For deep-seated lesions like glands in leukemia, he uses a hard tube and gives the exposures for fifteen minutes at six inches distance.

He repeats his exposures daily or every other day and of course to do this must use a very moderate amount of X-rays in his tubes. He is a strong advocate of light exposures frequently repeated.

Author's Technique.—I believe in comparatively short exposures at the start, especially in treating large areas on the face. I use a low or medium tube at about 6 to 10 inches from tube-wall to part under treatment and give 7-minute treatments three times a week during the first three weeks, when if no idiosyncrasy exists, and no reaction is present I lengthen the time of exposure to 10, 12 or 15 minutes and later bring the tube nearer the part under treatment.

With this method I have never as yet had any unfortunate results, although not always curing my cases as rapidly as under more heroic means.

Occasionally something about the appearance of the patient (especially the presence of illy-nourished tissues) causes me to shorten my preliminary treatments to 5 minutes each, while on the other hand in treating circumscribed areas, as in lupus or epithelioma, I usually start with 10-minute exposures; but in a localized eczema I would only expose 5 to 7 minutes. I have not hesitated to give 5-minute treatments daily in selected cases and occasionally have given two short exposures per day for a few days; preferring two short to one long treatment.

In treating lesions below the surface I use a medium or high tube according to the penetration required, and place the tube from 10 to 15 inches from the surface, giving an average exposure of 10 minutes, repeated every other day or else three times a

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week; often using a filter next the skin to lessen the external reaction.

Special variations in technique will be considered under the treatment of each disease.

In my office work I use an 18-inch induction coil, on direct current with mercury-turbine interrupter, giving 3,400 interruptions per minute. Current of 1 to 3 amperes in primary; one-half to one milliampere in tube-circuit. Self-regulating tube, enclosed in a shield.

Management of Apparatus.—In my clinical work I have often found that students who are able to tell correctly the general method of giving treatments are frequently perplexed when it comes to actually giving the exposures, over some minute or trifling detail.

For instance, 8 out of 10 students when they start to turn on the current, with an ordinary button switch, are at a loss to know whether to turn the button to the right or to the left.

Therefore, I will be pardoned in attempting to give a practical treatise, if I dwell on apparently inconsequential details.

The patient should be placed in a comfortable position in a chair or on a table as desired and if no tube-shield is used then employ some other form of protective device.

a. With the induction coil; direct current, turbine interrupter. Connect tube to coil, cathode end of tube connected to negative pole of coil. Adjust

tube to patient. Separate the adjustable spark-gap on one or both sides one-half inch, if low tube is to be used, farther if a higher tube is used.

Rheostat back at starting point.

Turn button marked "Motor" to right, which starts the motor of the interrupter.*

Then turn on the switch marked "Main," also turning to the right.

Always turn the motor on first and then the current through the coil.

Always turn off the main first and the motor last.

Always turn switch button to right, whether turning on or off.

Some coils have knife-blade switches in place of the buttons.

If tube does not light up, move rheostat slowly forward until it does. A steady buzzing sound will be present at the spark-gap and a blue spark may be seen. If interrupted, or irregular, too little current, so push rheostat farther around. If too thick and yellow, too much current, in which case rheostat is to be shoved back, or the adjustable spark-gap separated farther until sufficient resistance is introduced.

b. Induction coil, electrolytic interrupter. Only one button which turns to right, both in turning on

*In induction coils with turbine interrupter, there is one switch that starts the motor and another that sends the current through the coil. These are usually marked "Motor," "Main."

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and off. Same methods of adjusting tube and steadying current.

c. Static machine. Leyden jars off; tubes attached to special posts in front, extending up toward prime conductors. Prime conductors brought nearly together over the posts and rod in post adjusted upward to connect with knob of prime conductors or leave slight space, these taking the place of the adjustable spark-gaps on the coil. The current is taken from the prime conductors and carried through the tube circuit.

Ascertain negative pole and attach that side to cathode prolongation of tube.

Changes are being made so rapidly in apparatus that the operator must depend on the manufacturer for the necessary technique of managing his outfit.

CHAPTER IX.

Classification of Diseases Suitable for Treatment.

Classification.—In my lectures during the last few years I have been in the habit of classifying the diseases suitable for X-ray treatment under four subdivisions, which correspond somewhat to those given by Moncure.*

1. Diseases which require the X-ray only.
2. Diseases where the rays should be used before or after operation; or before and after.
3. Inoperable or incurable cases where the rays are used merely to prolong life and relieve pain.
4. Cases in which the rays are to be considered merely as one of various therapeutic measures that may be employed, or where their value has not been positively established.

1. Under the first heading I place acne, localized eczema, rodent ulcer, sycosis, epithelioma (before involvement of lymphatics), and most cases of lupus. I might add some other diseases, but these serve to illustrate the classification.

Nearly all of these cases can be cured with the X-ray alone; no other therapeutic measure being required.

I believe the failures are principally due to faulty technique or to the failure of patients to report regu-

*Charlotte Med. Journal.

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larly, rather than to any inability on the part of the ray to overcome the disease.

I do not mean to advocate the exclusive use of the X-ray in these cases, because one of its main advantages in any case is that it does not interfere with the employment of any other therapeutic measure, and a combination is often better than relying upon a single method.

2. Under the second heading I place such cases as tuberculous glands, early recognized cancer of breast or cervix uteri, etc., in which the employment of the ray may do away with the necessity of an operation; may lessen the amount of tissue required to be removed if operation becomes necessary; and may when used after operation prevent recurrence by destroying foci overlooked during the operation or which on account of location could not be removed.

Great caution should be observed against taking undue chances in malignant diseases of waiting too long before operation; so that if there be any serious doubt I would favor operation first and raying afterward.

However, there are many cases discovered so early that there seems to be no serious risk run in using the ray for from one to three months, with the possibility of avoiding operation and the probability of at least retarding the growth and lessening the extent of the operation.

On the slightest sign of increase or spreading of the growth, operation should be immediately resorted to and then followed by the ray.

I believe it is just as culpable to neglect to follow up the operation with the ray as it is to keep up the ray and neglect the operation. One is the complement of the other and both are necessary. Why should the patient be denied any measure which offers a fair probability of being successful?

3. Under the third heading are classed cases of inoperable malignant disease and those, too, which have progressed to the extent that the ray offers no likelihood of cure, but where it will retard the progress of the disease, prolong life and relieve pain.

4. The fourth class includes a large number of diseases in which the X-ray has been used, sometimes successfully, many times unsuccessfully; and in which other measures have been quite or even more satisfactory.

Here the X-ray is considered merely as one of a number of measures that may be used; its employment being largely in the nature of an adjunct to other means.

It also includes those diseases in which the ray has not been used sufficiently to enable us to speak definitely of its value.

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Part II.
PRACTICAL TECHNIQUE

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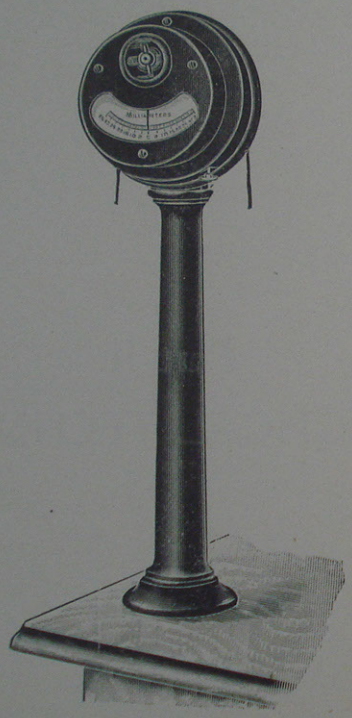

Milliammeter

CHAPTER I.

Diseases in Which the Value of the Ray Is Well Established.*

ACNE VULGARIS.

(Pimpies.)

Value of X-ray Treatment.—The treatment of this stubborn and unsightly disease has been revolutionized by the advent of the X-ray and other forms of light treatment.

If a physician will take the trouble to carefully treat a bad case of acne (for instance, one that he has previously failed to cure with drugs and ointments), using the X-ray alone, he will, by curing that case, make himself a permanent convert to the therapeutic efficiency of the Roentgen ray.

This was my own experience. At first, I believed in the ray to a considerable degree, but doubted whether it would really be sufficient to cure a very severe case; but finally after perfectly curing the

*For convenience, the diseases have been arranged alphabetically.

In giving the technique the terms high, medium and low as applied to the vacuum of the tube have been employed. For the benefit of those using the Benoist or Walter scale, the following equivalents may be borne in mind:

	Benoist.	Walter.
Low equals	1 or 2	1
Medium equals	3 to 5	2 or 3
High equals	6 to 12	4 to 6

With a milliammeter in the tube circuit, ½ to one milliampere of current should be passed through the tube.

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worst case of acne I have ever seen, either before or since, I became an ardent advocate of roentgen-therapy for this disease, and it is my belief that this is one of the diseases where failure must be due to poor apparatus, faulty technique, or irregularity on the part of the patient in appearing for treatment.

History of Treatment.—Shortly after the discovery of the X-ray and the demonstration experimentally of its action upon the skin, it was tried in various diseases of the latter. The first cases of acne treated by this method were reported Pokitonoff,* in 1897. Jutassy and Gautier were also early users of the ray for this purpose, and many operators working independently of one another employed it in their practice. In this country Campbell and Pusey were among the first to report the successful use of roentgentheraphy in acne.

Action.—The curative property of the ray is usually attributed to its atrophic action upon the sebaceous glands and its bactericidal properties.

Technique.—Adjust patient on chair or table, in a comfortable position. If no tube-shield is used, protect hair, eyes and eyebrows with leadfoil or any of the devices suggested in a previous chapter.

Some operators also protect lips, and if a man with a moustache, protect it also. I use a very low

*XII. Intern. Med. Congress, Moscow, 1897, Dermatological section.

tube, protected by a Friedlander shield. The patient may then sit on a revolving chair or stool and the large opening of the shield is brought within one or two inches of the patient.

If the pimples cover both cheeks and the chin, as they ordinarily do, one cheek is treated five to seven minutes and then the other the same length of time, and finally the chin is exposed with the patient facing the opening in the shield.

Where no tube shield is used and the tube itself is of a medium vacuum, the tube should be placed six or eight inches from the patient. Some operators expose from in front only, giving ten to fifteen minute treatments. I prefer treating one side and then the other and do not hesitate to lengthen the treatments to ten or twelve minutes after three weeks have elapsed without marked reaction. A short treatment should be given three or four times a week at first, and if no severe reaction appears, the length of the treatments may be increased, or their frequency. Short, frequent treatments, carefully persisted in will always bring results.

Auxiliary Treatment.—Although the X-ray alone is sufficient to cure acne, I find that the supplementary use of the high-frequency current, vibratory massage and radiant heat are valuable adjuncts and hasten the cure.

In applying the high-frequency current, I usually employ a medium spark (say one-half inch), from

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the vacuum tube, applied to the larger pimples for 30 to 60 seconds each, and sometimes I use a mild effleuve over the whole area, if pustules are numerous. Five to ten-minute daily treatments with the resonator are in themselves almost as effective as the X-ray.

The vibrator is employed with the vacuum cup in selected cases, giving a mild massage over the diseased surface and a vigorous stimulation of the lymphatics draining the area.

Suggestions.—I try to stop short of a visible reaction, but as this is usually impossible, it is perhaps better to say that a very slight reaction is all that should be produced.

I do not believe in using so much current that the opposite side of the head receives possibly more effective rays than the area under treatment.

We are not justified in so harmless an affection as acne in producing a reaction that may produce an unsightly, wrinkled or scarred skin, much worse in appearance than the disease treated.

If you have a chance to examine the hand of an operator who has exposed it unnecessarily to the rays for a long time so that some of the chronic effects are present, it will be seen that the skin contains numerous fine wrinkles.

These come as a result of the atrophic action of the rays and the increased production of connective tissue.

I have seen this same condition present on the face where radiations for acne or eczema had been too severe or were crowded too much.

In 1903 I reported a number of cases successfully treated without a visible reaction being present at any time.*

Never allow a patient to use vaseline on the face while under treatment. It favors the production of burns.

Never let the patient use ointments with metallic salts in them. They offer more or less obstruction to the rays.

Never open pustules until they are ripe. The common habit of deep lancing of pimples is pernicious in my opinion, and is responsible for the numerous fine scars to be seen on patients who have been subjected to it.

When a yellow head has formed on a pustule, open it carefully with a sterilized needle, and instead of using pressure with the fingers to expel the pus, press the shaft of the needle across the pimple and all the pus that is ready to come out will be removed. Then apply peroxide of hydrogen or any antiseptic solution.

Pressure simply breaks down nature's limiting wall and spreads the trouble.

This may be demonstrated easily by opening a pimple in the inflammatory stage and then squeez-

*American Electro-Therapeutic and X-ray Era, November, 1903.

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ing it well, and noting how much larger and angrier it will become in the next twenty-four hours.

Neither do I believe in the application of very hot water and hard massage as frequently recommended with the intention of stirring up the sluggish skin. If massage is indicated, let it be done carefully with the vacuum cup of a vibrator. Many skins will not stand any massage whatever.

A seasoned tube should always be employed unless some form of filter for the rays is used, in these cases preferably aluminum.

It will be observed that in women the face usually appears worse around the menstrual period.

Another point worth remembering is that the pimples are inclined to come in successive crops, gradually appearing in smaller numbers and with a longer interval of time between them.

ACNE ROSACEA.

(Red Nose.)

Historical.—As early as 1901, Gautier, Hahn and others reported the successful use of the X-ray in acne rosacea.

Bearing in mind the effect that the ray has upon the blood vessels, it seems reasonable to expect it to be almost uniformly successful.

Practically, I have found it of great value, but by no means a specific, and rather slow.

It is usually advisable to combine other treatment with it.

Boggs* believes the curative action comes principally through the atrophy of the sebaceous glands.

Technique.—Protect all of the patient's face except the nose and contiguous involved area, if any, with a lead mask, large enough to also shut out the rays from the hair on the head.

Bring the tube-wall within three to six inches of the nose, the principal ray directed on the tip of the nose.

In using a lead mask it is easier to treat the patient on a table or reclining chair.

*Treatment of acne and chronic eczema. J. A. M. A. Aug. 31, 1907, p. 736.
See also: Kanoky, Treatment of acne rosacea. Jour. Cin. Med. Aug., 1908.

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With a medium tube the distance should be about 6 inches from the tube-wall to nose, and the exposure 5 minutes, every other day.

If a low tube is used, the distance should be only 3 or 4 inches, with the same frequency and length of exposure.

If treatments can only be given three times a week I use the medium tube at 8 to 10 inches distance, with 10-minute exposures.

When a tube-shield is used, the aperture in the shield should be brought within 3 or 4 inches of the nose and the patient will be more easily treated when sitting in a chair. Use low or medium tube with same number and length of treatments.

Marked reaction is not very apt to occur early and may not be present at all.

Three months is about the shortest time in which positive results may be expected and no improvement may be noticed for several weeks.

After an apparent cure is effected, a treatment every ten days or two weeks should be persisted in for several months.

Auxiliary Treatment.—Electrolysis is of the greatest advantage in connection with the X-ray and I also employ the high-frequency current, from a resonator; using a mild spark from vacuum electrode for 2 or 3 minutes after each X-ray treatment.

Suggestions.—To the operator who is for the first time employing the X-ray therapeutically I would

suggest a little caution about the distance of the tube from the patient. It is better to have it a little farther away at first until the operator is able to discern readily the early signs of the reaction the ray produces in the tissues.

ACTINOMYCOSIS.

(Ray Fungus. Lumpy Jaw.)

The X-ray has been advantageously used in the treatment of actinomycosis.

Technique.—A 10 to 15 minute treatment three times a week with a medium tube placed 6 to 8 inches from the diseased area is suggested.

Auxiliary Treatment.—Electrolysis is frequently necessary in conjunction.

ALOPECIA AREATA.

(Baldness in Patches.)

Historical.—In 1900, Kienböck and Holzknecht both reported the successful treatment of alopecia areata with radiotherapy.

Remarks.—At first thought it would appear somewhat incongruous to expect to grow hair with an agent that is known to make the hair fall out, but on remembering that many cases of alopecia are of fungoidal or parasitic origin, it is not strange that in these cases, at least, the X-ray should be of great service.

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Technique.—The scalp is usually found to react readily to the X-ray, and it is therefore desirable to give comparatively short treatments, with a relatively higher tube and greater distance.

Protect all of the scalp except the area under treatment, making the aperture in the shield or mask take in a narrow margin (say half an inch) outside of the diseased surface.

Use medium or moderately high tube, 12 to 18 inches from surface and treat 5 to 10 minutes, three times a week.

The protection of the rest of the scalp in these cases is not, in my opinion, especially essential, because with as short treatments, so great a distance and so high a tube the healthy hairs are not very likely to loosen.

BLASTOMYCOSIS.

Historical.—The treatment of blastomycosis with the X-ray in conjunction with the internal use of po tassium iodide has been reported by Hyde and Montgomery, Pusey and others.

Technique.—Use a medium tube, 8 to 10 inches distance, three times a week or to the point of producing visible reaction.

Carcinoma, Before and After X-ray Treatment. (Dr. E. G. Williams' Case.)

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CARCINOMA.

(Cancer.)

No sane individual will today claim that the Roentgen ray does not favorably influence a reasonable percentage of cases of true cancer, if he will take the pains to investigate the records furnished by men of unquestioned standing and integrity.

This in spite of wide variations in technique and great differences in the mechanism employed to generate the ray, and especially despite the fact that many persons were treating cases who had practically no knowledge whatever, either of the X-ray, or even of general electricity.

Despite all of these conditions, a sufficient number of "cures" have been made to demonstrate the inherent qualities of the ray itself to destroy malignant growths.

At present I would place the number of symptomatic cures in favorable cases at about 20 to 30 per cent.*

*For purposes of comparison with surgical results, reference is made to an article by Finsterer, (Deutsche Zeit. f. Chirurgie, Bd. 89, H. 1-4), an abstract of which appears in the Therapeutic Gazette, of 520 cases of mammary cancer operated on in the Second Surg. Clinic, (Univ. of Vienna), from 1877 to 1903; permanent cure resulting in 12.5%.

A similar report by Steinthal, (Beit. z. Klin. Chirurgie, von Brun's, Tübingen XLVII, No. 1), summarizes 236 cases, with 16⅔% of cures. See also Therap. Gazette, Feb. 1908, p. 132.

E. G. Williams (Journ. A. M. A. Feb. 22, 1908) reports 107 cases treated with the Roentgen ray. He discards the term epithelioma, and divides all of his cases into six classes. I have tabulated his classes and results as follows:

How much greater the number of these symptomatic cures must be in the hands of competent operators and as our knowledge of the X-ray increases.

Historical.—The first case of carcinoma to be treated by Roentgentherapy was treated by Stenbeck of Stockholm in December, 1899. Since that time hundreds of cases have been treated and reported by operators throughout the world.

Technique.—It is not the object of this work to go into a resume of case histories, but to briefly outline the practical technique of treating these cases.

In the treatment of carcinomata the technique varies materially with the location of the lesion.

It must be borne carefully in mind that the object of the operator must be to place the tube at such a distance that the zone of spent or absorbable rays includes the diseased area, for without absorption there can be no physiological action.

In superficial growths a low or medium tube is

Class.	No. Treated.	Healed.	Improved.	Unimproved.
1. Superficial skin carcinomas.	54	53	—	1
2. Deep skin carcinomas.....	17	11	4	2
3. Extensive recurrent and metastatic carcinomas in deep structures	9	2	2	5
4. Carcinomas on mucous membranes	10	0	5	5
5. Primary carcinomas of the breast	2	1	—	1
6. Recurrent carcinomas of the breast	15	5	7	3
	107	72	18	17

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used. Whether a daily five-minute treatment at about 6 inches shall be given or whether 10 to 15-minute treatments three times a week are to be preferred, must largely be governed by the individual case.

I believe short frequent treatments are usually more satisfactory and more under the control of the operator than longer ones.

It is not always possible to have the patient come to the office every day and the treatment must be regulated accordingly.

It was formerly always considered necessary to protect surrounding parts with a shield, the aperture being cut to include a margin of one-half inch outside of the edge of the lesion.

As the whole success of the treatment depends as much upon preventing the spread of the growth as upon curing the visible lesion, I am coming more and more to the conclusion that no protecting shield should be used.

In this way every possible channel for the spread of the disease must come under the influence of the rays. Diseased tissue is known to yield more readily than the normal, and with mild, frequent treatments there is no great likelihood of producing a serious reaction in the surrounding structures.

The object of the treatment is to destroy the malignant growth, and if a slight reaction should be produced or a temporary falling of hair should

result, it is of much less consequence than the destruction of the cancer-cells.

A method I frequently employ about the face is to use the shield only about every third treatment.

In treating deep-seated lesions the tube should be high and removed 10 to 20 inches from the surface of the body in order that the growth may be affected before the skin shows too severe a reaction.

The effect on the skin may be obviated still further by passing the ray through a diaphragm of sole-leather as recommended by Pfahler; or through a thin aluminum shield.

Burdick considers a wet, folded towel ordinarily a sufficient filter to shut out the weaker rays which affect the skin.

Lanphear,* in internal cancer, operates and brings the growth to or near the surface, so that it is favorably located for X-ray treatment.

To summarize the technique:

a. Small superficial lesions at angle of nose; forehead; temple, or corner of mouth. Medium or low-tube, with or without shield, 6 to 8 inches distance; 5 minutes daily, for 10 to 15 treatments; then every other day; or 8 to 12 inches distance, 7 to 10 or even 15 minutes, three times a week.

b. About eye, protect eye-ball with a coin or small lead shield and treat as above.

*Journ. Clin. Med., May, 1907.

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c. Cancer of breast. Medium tube, 8 to 12 inches from lesion, 7 to 15 minutes, three times a week.

d. Cancer of larynx. Medium tube; 8 to 10 inches from surface; 10 minutes; three times a week. Protect face of patient.

e. Cancer of liver, stomach, bowel or other internal organ. High tube; 12 to 20 inches distance; 10 minutes, three times a week or 5 minutes daily. Filter out weak rays through leather, aluminum or wet towel.

f. Cancer of uterus. Treat through lead speculum; extension tube of protective shield; or specially constructed Crooke's tube; 5 minutes daily or 10 minutes every other day. Occasionally treat as for deep-seated lesion without using shield for the purpose of reaching areas contiguous to the lesion. Medium to hard tube; latter preferred.

Auxiliary Treatment.—The high-frequency current proves a valuable adjunct in superficial lesions.

I always employ mechanical vibratory stimulation to the lymphatics draining the diseased area; but never over the lesion itself.

This prevents engorgement of the lymphatics and probable involvement of them and lessens likelihood of undue reaction from the ray.

When to Use the X-ray.—Where operation is indicated and offers a reasonable probability of success it should be followed up by the use of the ray

to guard against extension and recurrence from overlooked cancer-cells.

Where the lymphatics are not involved a reasonable amount of raying should precede operation and may render the latter unnecessary.

In inoperable cases and recurrence after operation, the ray should always be used.

I agree with Witherbee* that the ray should be used **immediately** after operation. He says: "In regard to the time the X-ray treatment should be begun, the patient should be treated on a stretcher the day following the operation. This may seem rather a radical procedure, nevertheless the cells which may be in the open wound or in the adjacent tissue will be more completely destroyed in a much shorter time when the wound is fresh and open than when one waits for union before beginning treatment. The open wound not only greatly facilitates the direct action of the ray on the remaining cells, but also affords free drainage for all the lymphatic vessels in this region which may be laden with cancer cells."

De Roulet likewise advocates the use of the ray following the radical operation.

Strebel† has devised a special tube which he uses within the tumor mass, after preliminary incision.

In this connection I wish also to quote from an admirable article by Skinner‡, who says:

*Charlotte Med. Journal, June, 1906.
†Münch. Med. Woch., LIV, No. 11 (1907).
‡Jour. Amer. Med. Assoc., Nov. 10, 1906.

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"1. A large proportion of recurrent malignant growths does not respond kindly to Roentgenization, perhaps because of the increased malignancy with which operative interference seems to imbue some cancers, notably sarcomas.

"2. If Roentgenization is delayed until recurrence is manifest, the process may then have become so widely disseminated as to preclude the possibility of benefit from radiation.

"3. If the affected area is radiated immediately after radical extirpation of the lesion, the degree of remedial (destructive?) influence demanded of the ray will be limited to such as will be necessary for the elimination of miscroscopic foci of malignancy, whereas if recurrence is awaited the remedial influence required will be much greater because the lesions will be much larger and better developed, and the degree of increase demanded may be so great, especially when deeply-located structures are involved, as to be impossible of attainment. Under such circumstances we would be confronted with a condition which might have been eradicated had we acted promptly, but which our omission had allowed insidiously to develop and compass the destruction of the patient.

"4. We know that in a certain proportion of cases treated by a cutting operation alone, recurrence will not take place and the cure will be radical. On the other hand, we also know that we never can

assure any one patient that recurrence will not take place in his case, and we are perfectly certain that recurrence will declare itself in a large proportion of all cases. If immediate post-operative Roentgenization is omitted in any one case, that may be the very one in which we shall encounter recurrence, and it is highly probable that had we applied the ray immediately after the operation the accident would have been prevented. By Roentgenizing every operative case we are assured of having exerted every effort for the relief of the patient, and that we have saved all of our patients that it was possible to save.

"5. It is imperatively incumbent on us to apply any measure which has the power to destroy or inhibit malignancy, to the task of lessening the proportion of post-operative recurrences; that the Roentgen ray manifests such a power is proved beyond a doubt, and the clinical experience of those who have thus employed it, with a correct technique, has amply confirmed the validity of this contention."

Results.—Burdick* sums up the changes under treatment as occurring in the following order:

1. Relief of pain.
2. Decrease in or disappearance of hemorrhage or discharge.
3. Gradual atrophy of the glands.

*Wisconsin Med. Recorder, Feb., 1904.

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4. Active congestion of the tumor.
5. Gradual absorption of the tumor.

He says: "In the majority of cases, however, we find that a certain amount of the tumor will remain, and may be removed or let alone, as may be thought best by the attending physician, as either method seems to offer equally good results, as the tumors have shown no tendency to grow in the eighteen cases that have been under my observation for over three years."

Suggestions. — Persistence and perseverance count.

Cancers involving mucous membranes do not yield readily to the ray.

Bear in mind that with our present methods of measuring the rays probably no two exposures are ever exactly alike.

In general, use a seasoned tube, especially in treating deep-seated growths.

Additional literature on X-ray treatment of cancer.

Abstract of Report on French Congress of Surgery, Paris, 1907, (translated by Heineck from Revue de Chirurgie). See Surgery, Gyn. and Obstetrics, Feb., 1908.

Morton. Treatment of Cancer by the X-ray, with Remarks on the Use of Radium. Internat. Journ. of Surgery, Oct., 1903.

Rudis-Jicinsky. Inoperable and Deep-seated Carcinomas and Their Treatment with Roentgen Rays and Radium. Journ. Amer. Med. Assoc., Jan. 12, 1907.

Williams. X-ray Treatment of Malignant Growths, J. A. M. A., May 6, 1905, and Jan. 26, 1907.

Johnston. Radiotherapy in Malignancy. Amer. Med., Oct., 1907.

ECZEMA.

Historical.—The first records that I find of the use of the X-ray in eczema are by Hahn[1] and Albers-Schönberg[2] in 1898 and Mackey[3] in 1899. Ullman[4], Jutassy,[5] and Schiff and Freund[6] reported cases in 1900.

Remarks.—My own first experience with it occurred in 1902 when I cured in nine treatments a case of chronic eczema of the right cheek, which had existed for a number of years.

After this I naturally made use of the ray at every opportunity, and I believe chronic eczema is, theoretically, always curable by this agency.

Unfortunately, faulty technique and failure of cooperation on the part of the patient are features that have reduced the proportion of cures to about 90 per cent.

There is no doubt that relief from itching is experienced even in acute eczema, in most cases, but it is in the chronic forms, characterized by obstinate indurated patches that the X-ray becomes almost a specific.

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[1]Freund's Text-book, p. 237. Kassabian's Text-book, p. 211.
[2]Fortschrift. a. d. Geb. der Roentgenstrahlen, 1898, II, p. 20.
[3]British Journ. Dermatology, 1899, XI, p. 166.
[4]Wiener Med. Presse, 1900, XLI, p. 954.
[5]Fortschrift. a. d. Geb. der Roentgenstrahlen, 1900, III, p. 119.
[6]Ibid., p. 109.

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The ray acts quickly upon eczema and results are obtained in a comparatively short time.

Technique.—I prefer a very low tube, one in which fluorescence is scarcely noticeable except in a dark room.

I place the tube within 3 or 4 inches of the surface to be treated, protecting surrounding parts, if on the face. A 5-minute treatment is given every other day or three times a week.

The reaction is ordinarily quick to appear.

In treating a large area I frequently use a medium tube, placed at 8 or 10 inches distance and give 7-minute exposures.

If no reaction occurs in three weeks, the time is lengthened to 10 minutes.

Improvement frequently takes place after one or two exposures.

Auxiliary Treatment.—I find that the high-frequency current through a vacuum tube, is nearly or quite as effective as the X-ray and therefore I usually employ it at the same time.

I use a mild spark (about one-third to one-half inch in length), keeping the tube touching the surface part of the time, and part of the time raised to get the full effect of the spark; but always passed rapidly back and forth over the tissues. In cases of intense itching I can usually relieve it in thirty to sixty seconds with a very sharp spark.

Considerable reaction quickly follows the use of the high-frequency current. It has the advantage of not being as dangerous as the X-ray and is nutritional and upbuilding rather than destructive in its action.

The Leuodescent light has also given me satisfactory results.

None of these measures interferes with the employment of any local or constitutional remedies that the physician may see fit; except that no ointments should be used containing a mineral that will obstruct the passage of the Roentgen rays.

EPITHELIOMA AND RODENT ULCER.

(Skin Cancer.)

General Remarks.—No other disease has done as much to bring the X-ray into prominence or to call attention to its therapeutic worth as cutaneous cancer.

I class it with those diseases that are entirely amenable to careful and proper X-ray treatment, provided this is begun before there is any glandular involvement.

In these favorable cases I believe the number of apparent cures is not less than 80 to 90 per cent. In miscellaneous cases, including those with gland-

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ular involvement, the "cures" average 60 to 70 per cent.*

This in spite of many and varying techniques; good, bad and indifferent apparatus, etc.

Under proper conditions it is not unreasonable to believe that the percentage of symptomatic cures should be greatly increased.

I exclude cases where involvement of the skin exists as a result of metastasis from other areas as well as those cases where the glands or deep-structures have become diseased.

So much has been written on this subject and so many favorable reports have been made that it seems superfluous for me to enter into any lengthy discussion of it.

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*Pusey, Journal American Medical Association, January 11, 1908, reports on 111 cases of epithelioma treated more than three years previously to July, 1907. He sums them up in four groups, as follows:

1. Successful ..... 80 cases
2. Practically successful ..... 2 cases
3. Distinctly benefited ..... 17 cases
4. Failures ..... 12 cases

This makes 72% of absolutely successful cases, and it is interesting to note that 39 of the 80 cases cured were recurrences "after previous radical treatment, usually operation."

Heyerdahl, Norsk Magazin for Laegevidenskaben, Christiania, LXVII No. 3. Abstract J. A. M. A., April 28th, 1906, reports 11 cases of rodent ulcer, all of which were cured; also four of superficial epithelioma. He states that rodent ulcers yield more rapidly than epithelioma.

See reference to E. G. Williams' results under carcinoma.

See also, Schiff, Lancet, November 23, 1907, Treatment of Epithelioma with Roentgen rays.

Soiland, Calif. State Jour. of Med., August, 1907, presents a series of photographs in 13 cases showing the results of X-ray treatment in superficial malignancies, which prove as he says, that "from a therapeutic standpoint the Roentgen rays are neither a travesty nor quackery."

Bulkley and Janeway in the Medical Record, March 21, 1908, give a résumé of the results in 400 cases of epithelioma, which makes an interesting comparison of caustic pastes, X-ray and operative measures.

Historical.—The first case in which Roentgentherapy was employed was reported in 1900 by Stenbeck* of Stockholm. This was a case of rodent ulcer.

Sjögren shares in this honor and in this country W. Merrill and W. Johnson treated a case in 1899.‡

Surgery.—It is not the intention of this article to decry the use of surgical measures to remove suitable cases of cutaneous cancer. A judicious combination of surgery and X-ray will be found a most valuable combination. I believe, however, that the X-ray should always be used after operation and in the majority of operative cases, both before and after.

Where the growth is spreading rapidly and glandular involvement exists it would be unwise to delay, and I would advise immediate operation, followed by a course of Roentgentherapy. In otherwise healthy individuals where the lesion is not growing very fast, the X-ray should always be used before operation is resorted to.

Due consideration must be given to the location of the ulcer; for instance, glandular involvement is much slower to occur with the disease on the upper lip, than when it is on the lower.†

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*XIII Internat. Med. Congress, Paris, 1900.

‡Reported in Phil. Med. Jour., Dec. 8, 1900. (Kassabian's text-book, p. 460.)

†As a rule, epithelioma on the lower lip should be operated on at once and then followed up by the ray.

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Technique.—I customarily protect surrounding structures with a lead shield, the opening being sufficiently large to include the diseased tissue and an area about one-half inch greater of sound tissue about its margin. I leave this shield off every third or fourth exposure in order to be certain of reaching all contiguous areas where possible cancerous foci may exist.

A medium or low tube is used, and the lower the tube the nearer the wall of it is placed to the surface treated.

In certain cases about the face I fasten on a little gauze with an opening cut in it and bring the aperature of my tube shield in contact with the gauze.

In this case the tube wall is only 2 or 3 inches from the lesion, and I use the tube as low as the vacuum can be reduced to ; (with the ordinary tube I keep the regulating wires at cathode end, touching), and employ very little current through the coil. Use an old tube, and 5 to 8 minute exposures every other day.

I would not suggest this method until the operator became thoroughly familiar with his apparatus.

For the beginner I would advise the use of a medium or low tube at a distance of 6 to 10 inches, according to the vacuum of the tube. Give preliminary treatments of 7 to 10 minutes, and then increase length of treatment to 10, 12 or 15 minutes; exposing every other day, until reaction is produced.

With the surrounding tissues protected you need not care particularly about the amount of reaction, as a good reaction is what you are after, and you cannot produce a cosmetic effect any worse than the cancer itself produces.

These are the cases where the seriousness of the disease excuses the production of a considerable "burn" if that should happen.

Auxiliary Treatment. — Sharp, high-frequency spark, 3 to 5 minutes daily or every other day, is advantageous and is itself curative.

The same may be said of intense white light (the Leucodescent light).

In certain cases I use vibratory stimulation to the lymphatics draining the diseased tissues.

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FAVUS AND TINEA TONSURANS.

(Ringworm of the Scalp.)

Historical.—In 1897 Freund advocated the use of the ray in these cases, and in 1899 in conjunction with Schiff he reported the successful treatment of these troubles.

Technique.—One method of procedure is to use a high tube at about 15 inches distance, giving a 5 to 7 minute exposure three or four times a week. The object in this case is to eliminate the softer rays so that too quick a reaction may not be produced in the scalp, which is unusually susceptible to the rays.

I find that a medium tube at 10 inches with 5 to 7 minute treatments is perfectly satisfactory. An old tube is used.

It is usually necessary to carry the treatment to the point of making the hair fall out, as upon this especially depends the value of the treatment.

The hair returns after a time, and then greater care must be exercised in the amount of reaction produced, lest by causing it to fall a second or third time it may cause permanent baldness.

Macleod* has investigated with reference to possible injury to the brain resulting from treating the scalp, but finds no evidence to justify any such assumption.

*Lancet, May 15, 1909.

GOITER.

(Simple Goiter and Exophthalmic Goiter.)

General Remarks.—It is still problematical whether the X-ray is really curative in goiter or not. Pusey in his text-book reports three cases, in one of which there was improvement and two of which showed none.

In an article in the Journal of the American Medical Association, May 13th, 1905, he reports in some small "parenchymatous goiters there had been permanent diminution in their size. In one of these cases the gland has shown no returning enlargement after eighteen months. In most of the cases, however, there has been no benefit."

Mayo* reports marked benefit in exophthalmic goiter, "sufficient to give this method a place in the treatment of Graves' disease."

Pfahler† notes improvement in 28 out of 31 cases, while Dock,‡ after treating 32 cases of the exophthalmic form, considers it merely an adjunct to other measures.

Pfeiffer (Beitrage z. klin. Chirurgie, von Brun's Tübingen, XLVIII No. 2) concludes from the results in 51 cases treated in von Brun's clinic that the Roentgen ray is usually ineffectual.

*Medical Record, Nov. 5, 1904.
†Therapeutic Gazette, Mar. 15, 1906.
‡La Tribune Medicale, Jan. 27, 1906. Kassabian's Text-book, p. 491.

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Cook (Journ. A. M. A., March 7, 1908) reports on 5 cases of exophthalmic goiter treated by a combination of radio-therapy and high frequency with a cure in those cases where treatment was regular and persisted in, and marked improvement in all of the cases treated.

Faber (abstract in Jour. A. M. A., November 2, 1907) reports use in four cases of simple goiter with benefit in all, one being entirely cured and another reduced one-half. He also treated 8 cases of exophthalmic goiter with "remarkable results."

Freund (Münch, med. Woch., LIV, No. 17, 1907) reviews the work of a dozen operators, and reports five cases of exophthalmic goiter treated by himself with unmistakable benefit in all. Two had had no signs of recurrence for a period of 15 months. He used a moderately soft tube at 8 inches, exposing 8 to 10 minutes.

I began using the X-ray in goiter in 1902, and the two cases that I treated at that time, one being exophthalmic, the other simple goiter, both yielded so quickly to the ray that I was satisfied it would prove a specific.

Subsequent experience has not borne this out. Some cases that would seem especially suitable for treatment have given practically no results whatever, while in several cases of exophthalmic goiter the result has been beyond my expectation.

I would place the number of symptomatic cures at about 50 per cent.

Technique.—I use the X-ray with a medium tube at a distance of 5 to 8 inches and give a 5 to 7 minutes exposure. This I repeat three or four times a week. I do not try to produce visible reaction, as I have found that this gave no better results.

Auxiliary Treatment.—At the present time I always combine with the X-ray the use of the high-frequency current and mechanical vibration. In selected cases I also use galvanism, and internal medication.

The use of serums has proved them worthy of trial in those cases which resist the ray.

My routine treatment now is to follow up the X-ray with the high-frequency from the vacuum tube, using as sharp a spark as the patient can stand; passing the tube rapidly back and forth over the goiter for three to five minutes, after which I use the vibrator over the goiter for a few seconds and then to the neighboring lymphatics, including those under the arm.

In one large case I reduced the circumference of the neck at the rate of an inch per month. In another apparently similar case, three months' treatment showed only half an inch difference in measurement.

Some small goiters reduce rapidly but tend to return in a few months.

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HYPERIDROSIS.

(Profuse Sweating.)

General Remarks.—From the nature of the action of the X-ray upon the skin, where it produces atrophy of the skin and all of its elements, including hair-follicles, sebaceous glands and sweat-glands, it was inferred that it would be useful in cases of profuse sweating where confined to local areas, as the arm-pits or feet.

It does not seem to produce as much relative atrophy in the sweatglands as it does in the hair-follicles or sebaceous glands, but has proved quite efficacious in relieving the distressing symptoms arising from the over-activity of the former.

It has also been found useful in destroying the micro-organism giving rise to the disagreeable odor accompanying some of these cases.

Technique.—I have employed a medium tube placed at about 10 inches distance with seven to ten-minute exposures, three times a week.

I have found the arm-pits to stand relatively more of the rays than the feet; and if the circulation is sluggish in the extremities care must be exercised in the application of the ray. as it is found that "burns" appear quickest in those parts having the poorest circulation.

Some operators in treating hyperidrosis prefer to give a twenty-minute treatment with a medium tube at 10 to 12 inches and then not repeat the treatment for a week.

HYPERTRICHOSIS.

(Superfluous Hair.)

History and Remarks.—When Freund reported in 1897 the successful treatment of a hairy naevus, the epilating effect of the Roentgen ray was heralded as a remedy for all forms of hypertrichosis.

Experience has shown that while the ray certainly does have a positive effect upon the growth, it cannot be used with uniform success in all cases of superfluous hair.

My experience dates back to 1902 and I have treated a large number of cases.

As I have been accustomed to tell my classes, I have been most successful in removing hair in those cases that I did not have any intention or desire of such results, and in the cases that I have tried my best in it has often proved partly or wholly unsatisfactory.

I have found that in blondes, with a fuzzy growth on cheeks or chin, it was comparatively easy to cause the falling out of the lighter or more downy hairs; but unfortunately it is in brunettes where this growth is usually stronger and more conspicuous that relief is more often sought, and I have found it extremely difficult to cause the hair to fall in brunettes without taking chances of a severe and possibly disfiguring dermatitis.

At the present time I do not advocate the use of the ray for this purpose for purely cosmetic purposes. If the hair covers and interferes with a dis-

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eased area it is another matter and some chances may be taken; but the larger number of cases applying to me have been women who had more beard or mustache than they cared for, and in only about one-half of these cases has the ray proved successful.

A more satisfactory way has been the combination of the ray with the electric needle; using the ray to cause the lighter hairs to fall and to weaken the growth of the coarser ones, but depending upon the needle to remove the latter.

Technique.—I usually employ a low tube, emitting copious but very weak and easily absorbable rays, placing the tube-wall four to six inches from the area treated and expose for 15 to 20 minutes, two or three times a week until reaction appears. It is usually necessary to establish considerable reaction to make the hairs drop.

Protect eyes, lips, hair of head or parts not requiring ray, with lead-foil or other shield.

If on both cheeks and on chin or lip, expose one cheek and then the other and finally from in front.

After the hair falls once it will ordinarily return in the course of three to six months; therefore it is desirable to give an exposure once in ten days or two weeks after epilation takes place to prevent this return.

Otherwise the same procedure must be gone through with again; but after it has fallen out a second time it rarely returns.

KELOID.

Historical.—The cure of keloid by means of the X-ray has been reported by many operators.

Edwards* reports three cures.

Burdick† reports cure of a case with no return in five years.

Pain disappears early in the treatment.

Gradual shrinking or retrograde metamorphosis takes place, leaving a soft, pliable scar.

In some cases it does not seem to be possible to carry the treatment to the desired point and a portion of the keloid may remain.

Pusey§ reports successful treatment of a case of keloid, which required over 80 exposures to produce any effect; but after the production of an acute dermatitis the keloid rapidly disappeared.

Author's Technique.—Medium tube; 8 to 10 inches, every other day to point of good reaction if necessary; 10-minute exposures.

Barnum ‖ prefers a high tube at 15 to 20 inches, with 15 to 25 minute treatments every other day for ten days; then no exposures for ten days and repeat.

*Int. Journ. Surgery, Oct., 1903.
†Wis. Med. Recorder, July, 1905.
§Text-Book, p. 559.
‖Trans. Amer. Roentgen Ray Society, 1906.

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KERATOSIS (SENILE).

This harsh, horny condition of the skin which is not uncommon among old people is claimed to often pave the way for epithelioma, and it is therefore fortunate that the trouble seems to yield almost uniformly to the action of the X-ray.

Technique.—Low tube, 6 to 8 inches; 5 to 7 minute exposures; three times a week.

Auxiliary Treatment.—Both the high-frequency current and the leucodescent light are valuable aids.

LEPROSY.

Some years ago in considering the various diseases that might yield to X-ray treatment it occurred to me, as it undoubtedly did to many other operators, that leprosy might come within this classification.

When, later, one of my post-graduate students, a physician from Hawaii, called my attention to the similarity between one type of leprosy and tuberculosis, I was thoroughly convinced of the possibilities of the ray, and was not surprised therefore, when I read Wilkinson's excellent article on this subject, and noted his successful results.*

*Journal Amer. Med. Assoc., Feb. 3, 1906.

He reports 13 cases, of which 3 were cured; 7 improved; and three unimproved.

The earliest reports given of the treatment of this disease with the X-ray are by Sequeira† and Scholtz§.

Matthews‖ reports satisfactory results in 7 cases. He combines high-frequency with X-ray.

Technique.—His general technique was to expose the selected area about 10 minutes at a distance of 7 to 10 inches. He aimed to stop just short of a burn.

LEUKEMIA AND PSEUDO-LEUKEMIA.

(Leucocythemia and Hodgkin's Disease.)

History and Early Reports.—During the past five years, more than a hundred articles have appeared in the medical press concerning the X-ray treatment of leukemia and pseudo-leukemia.

The majority of the reports show markedly successful results in these diseases.

The credit for priority in the use of radio-therapy in these conditions is due to Dr. W. A. Pusey, who demonstrated cases of Hodgkin's disease before the Chicago Medical Society, Feb. 26th, 1902, and at that time referred to a case of splenic leukemia in which the rays had proved a failure.

†Brit. Med. Journ., Sept. 28, 1901.
§Arch. für Dermat. Med. Syph., 1902. Vol. LIX, p. 443.
‖Indian Med. Gaz., Aug., 1908.

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These were reported in the Journal of the American Medical Association, Jan. 18th and April 12th, 1902. The treatment of the first case began in Sept., 1901.

In the same year reports of symptomatic cures of pseudo-leukemia were made by Hett[1], Williams[2], and Dunn[3]. These were followed by others in 1903 by Childs[4] and Senn[5].

Results of Treatment.—Schirmer[6] reviews the records of 72 reported cases, and states that in nearly every case the general health was greatly improved. The blood improved or became normal and the spleen decreased in size.

Recurrences in a number of cases came after the lapse of a few months, but usually yielded to a repetition of the treatment.

Holding and Warren[7], discuss 25 cases of splenomyelogenous leukemia, gathered from the literature on the subject. They report 8 cases symptomatically cured; 15 improved and 2 not benefited.

Of 8 cases of lymphatic leukemia, 3 were improved, 5 were unimproved or fatal.

Of 22 cases of pseudo-leukemia 6 were apparently cured; 13 improved; and 3 unimproved or fatal.

[1]Hett. Dominion Med. Monthly, Aug., 1902.
[2]Williams Text-book, p. 675.
[3]Dunn. Amer. Pract. & News, Oct., 1902.
[4]Childs. Med. News, Jan., 1903.
[5]Senn. N. Y. Med. Journ., Apr. 18, 1903, and Med. Record, Aug. 22, 1903.
[6]Schirmer. Centralblatt f. d. Grenzgebiete, Jena, 1905, VIII. Abstract in Journ. A. M. A., Aug. 5, 1905.
[7]Holding and Warren, N. Y. Med. Journ. Nov. 11, 1905.

Arneth[8] asserts after careful study of the blood findings that the X-ray acts upon leukemia favorably, but indirectly, and in the same manner that quinine does on malaria; not by curing the lesions, but by destroying the parasites which produce them.

This calls, therefore, for a more general administration of the rays. He is convinced that the consumption of neutrophiles, eosinophiles and mast cells is lessened, but believes the normal condition of the blood is never quite reached.

Flesch[9] speaks discouragingly of the use of roentgentherapy, claiming that only a transient improvement may be expected. He bases his views largely upon three cases treated by him.

Pusey[10] reports continued success with these cases and believes the case of leukemia which he treated first and pronounced a failure, received insufficient treatment. The case of pseudo-leukemia, demonstrated before the society, has had two slight relapses, occurring in two and three years, respectively, both yielding readily to the ray.

Pancoast[12] has followed up 123 of his own and collected cases, including leukemia, pseudo-leukemia, polycythemia, splenic and pernicious anemia. Of 63 cases of leukemia, 4 are living and well; 16 were ap-

[8]Arneth, Berlin. Klin. Wochenschrift, 1905, XLII No. 28 and Muenchener Med. Woch. 1905, LII Nos. 33 and 34.
[9]Flesch. Deutsche Med. Wochenschrift, 1906, XXXII No. 18.
[10]Pusey. Journ. Am. Med. Assoc., May 13, 1905.
[11]Franke. Wiener Klin. Wochenschrift, 1905, XVIII No. 33.
[12]N. Y. Med. Jour., Mar. 23, 1907, quoted from abstract from Journ. Adv. Therapeutics, Sept., 1907.

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parently cured but finally relapsed and proved fatal; 5 symptomatically cured relapsed but are still living, though their condition is serious; 18 improved, but relapsed and died of leukemia or intercurrent disease; 16 were essentially unimproved and died; 4 which had been apparently cured had relapsed and were still under treatment.

Of 35 per cent but 6 were well 3 to 6 years after first being apparently cured. He also found that a toxæmia was often caused by the treatment which hastened death.

Of his cases of pseudo-leukemia, of which there were 44, it had been possible to learn the final results in 29 cases or 66 per cent. Of these 27.6 per cent are still apparently cured, 3 or 4 years after the original symptomatic cure; 65½ per cent are dead or nearly so; and 6 9-10 per cent are still under treatment.

Later Reports.—Since the publication of the first issue of this book many new reports have been made concerning these diseases and the opinion is fast growing, that especially in leukemia the patients finally succumb to the disease; but despite this fact the Roentgen ray is the best treatment we possess and should always be employed.

Stengel and Pancoast[13] state that the secondary

[13]Stengel and Pancoast. A New and More Rational Treatment of Leukemia by the X-ray. Jour. Amer. Med. Assoc., April 25, 1903. Also a paper by Pancoast in the Therapeutic Gazette, August, 1903.

lesions show a large proportion of myeloid elements, or apparently a myeloid transformation of the normal structure, and incline to the belief that this is due to a "metastatic deposit of myeloid elements, with subsequent proliferation in loco."

Commenting on the 123 cases previously reported by Pancoast (see preceding section), they show that the permanent cures at the present time are only 8.7 per cent of the total number treated (decided improvement, however, occurred in 66 2-3 per cent).

Another point emphasized is that the total leucocyte count as an index of the effect of the treatment is of much less value than the differential count and the general qualities of the blood.

They advise against early exposure over the spleen, this being the essential variation from the old technique. The bone-marrow is exposed first, later the spleen and glandular elements. They state that the spleen decreases in size under applications to the bone-marrow, just as it does under direct exposure, and the toxæmia frequently resulting from the latter is thereby avoided.

Capps and Smith[14] show that the serum of patients under treatment for leukemia develops leucolytic properties and is capable of destroying other leucocytes, not only within the patient's body, but also when injected in another. The inference is clear.

[14]Jour. of Exper. Med., January, 1907.

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Königer [15] advocates exposure of the spleen only.

Joachim[16] claims better results from treating spleen and lymph glands, rather than bones.

Elischer and Engel[17] believe strongly in the efficacy of X-ray treatment, though they have not seen any permanent cures.

Warthin[18] compares the X-ray with the administration of arsenic in leukemia. He notes the leucolytic action of both; does not believe any permanent cure has been made by the ray, but believes it superior in the production of a symptomatic cure, and that the period of improvement is longer. He advises the alternation of the two.

Technique.—For pseudo-leukemia I prefer a medium or rather high tube at 10 to 12 inches; exposing over each group of enlarged glands, from 7 to 10 minutes, three times a week.

In leukemia I also expose over the spleen and over the long bones—in short, general radiation. Hereafter I shall try the method of Stengel and Pancoast of leaving the glands and spleen for later treatment.

A low tube should be avoided, as most of its rays will be absorbed by and expend their effects upon the skin and the result of the necessarily long-continued treatment will merely be to produce an extensive surface dermatitis.

[15] Deutsches Archiv, f. Klin. Med., Leipsic, LXXXVII No. 1.
[16] Zeitschrift f. Klin. Med., Berlin, LX No. 1.
[17] Same, LXVII, abstracted in Jour. A. M. A., January 30, 1904, p. 427.
[18] International Clinics, Vol. IV.

Pusey exposes over spleen and then gives an exposure taking in all of the body except the head.

Burdick advocates general radiation.

Franke[11] exposed over the spleen only, with beneficial but temporary results.

I quote the following from an abstract of Schirmer's article:

"The enlarged glands (in pseudo-leukemia) subside more slowly than the enlarged spleen as a rule. On account of the multiple localizations, the exposures were generally more numerous and more intense than in the cases of leukemia, and by-effects were more frequently observed. Hard tubes mostly were used."

"Milchner and Mosse advise exposure of the peripheral portion of the bone-marrow rather than the center, as more cells are accumulated at the periphery."

"Perthes covers the skin with a sheet of tin foil to divert any possible soft rays."

"Guerra enhances the activity of the rays by preliminary subcutaneous injection of methylene blue."

"Levy-Dorn recommends what he calls radial exposure—that is, to expose the focus on two or more sides, in order to insure the deeper penetration of the rays. A large proportion of the Roentgen energy is lost by the resistance of the tissues. He advocates increasing the distance to 30 cm. (12

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inches), as the penetrating action of the rays under the skin does not diminish in the same proportion as their action on the external skin.

"He thinks that too abrupt resorption of pathologic masses is liable to be injurious."

"A larger number of 'refractory' doses is borne much better. His method of partial radiation of the single glands and groups of glands seems logical.

"Heineke's researches are cited by Schirmer as having established a scientific basis for all this empiric work."

Auxiliary Treatment.—Mechanical vibration will be found of great value in aiding in the elimination of broken down materials.

High-frequency currents are contra-indicated.

Caution.—On account of the numerous areas requiring radiation, the importance of the administrations being given by an experienced operator is at once apparent. Great harm may be done with so powerful and subtle a force as the X ray by those who only partially understand it.

Attention has been called to the dangers of belated burns—i. e., burns appearing some time after treatment has been discontinued.

Additional literature:
Musser & Edsall. A Study of Metabolism in Leukemia Under the Influence of the X-ray, Univ. of Penn. Med. Bull., Sept., 1905.
Aubertin. Roentgen Treatment of Leukemia, Semaine Médicale, XXVI No. 39.
Buchanan. Effect of X-rays on Leucocytes in Leukemia. Brit. Med. Jour., July 14, 1906.
Rosenstern. Metabolism in Leukemia Under Roentgen Treatment. Münch. Klin. Woch, LIII, No. 22.

LIPOMA.

(Fatty Tumors.)

Several cases have been reported of the successful treatment of fatty tumors by roentgentherapy.

A medium tube was used at a distance of 8 to 10 inches, and ten-minute treatments given, three times a week.

I have had no opportunity of testing the value of the ray in these cases.

LUPUS VULGARIS.

(Tuberculosis of the Skin.)

Historical.—The first therapeutic application of the X-ray was in a case of lupus vulgaris. This was by Schiff and Freund in 1897.

This disease has shown itself especially amenable to the Finsen light, and to the high frequency current as well as to the X-ray.

The advantage of these forms of treatment over other methods, from a cosmetic standpoint, renders them very valuable.

Van Allen, (Jour. A. M. A., Feb. 2, 1907,) reports 15 cases with 80 per cent of cures. Three months was the shortest and 9 months the longest time and 6 months was the average. Wills, (Bristol Medico-Chirurg. Jour., June, 1907,) believes from his experi-

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ence that the X-ray is superior to the Finsen light, except in nodular cases, where the light has proved superior.

Technique.—If the lesion is located on the face the surrounding parts should be protected by a lead or other mask, the opening in the shield being at least half an inch larger all around than the diseased area.

A protective shield with an extension tube makes a convenient arrangement for treating this trouble. In locations other than about the face it is scarcely necessary to protect surrounding structures.

I use a low tube placed close to the lesion, say 4 to 6 inches from the tube wall. A 10-minute exposure three times a week is found satisfactory, although where circumstances permit, a 5-minute treatment almost daily will be found efficacious.

Auxiliary Treatment.—The high frequency current has proven practically as curative as the X-ray and is found especially advantageous in conjunction.

Use the mild effleuve or direct contact with the vacuum tube for 5 to 10 minutes after each X-ray exposure.

The Finsen light is possibly superior to the X-ray in the treatment of lupus but owing to the scarcity of apparatus in this country the cases must largely be treated by other methods and the ray is much

more convenient and easier to use and its results are essentially the same.

Remarks.—The percentage of cures as gleaned from various sources shows an average of about 80 per cent. Bullitt* gives a record of 420 cures out of 616 cases or 68 per cent; this I understand to include lupus erythematosus as well as lupus vulgaris.

Carbon dioxide snow has been used recently with successful results, especially in destroying nodules.

*Transactions American Roentgen Ray Society, Sept., 1904.

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MYCOSIS FUNGOIDES.

This painful and otherwise incurable disease has been successfully treated with radio-therapy.

Reports of Cures.—Markley† calls it the most active agent yet discovered for relieving this torturing disease.

The case reported involved practically the whole body.

A soft tube was used, at a distance of 8 inches; each area being exposed 5 minutes.

It was necessary to make about 12 exposures at each sitting. Two treatments a week were given at first.

Mild and soothing lotions were used to alleviate the itching.

In 6 weeks a cure was essentially effected. The skin was deeply pigmented but soft and smooth.

Burdick* reports a case in which the disease had been present four years and the tumors had been removed several times by surgical methods, only to recur promptly.

The woman had more than ninety tumors of varying sizes and all suppurating at the time she commenced treatment.

In 8 weeks he had caused the disappearance of all but a single tumor, when patient stopped. Recurrence took place but yielded in 6 weeks.

*Wis. Med. Recorder, July, 1905.
†Journ. Cutan. Dis., Oct., 1905.

A year later a slight recurrence took place again but was quickly cured.

He reports successful results in five other cases.

White and Burns, (Jour. Cutan. Dis., N. Y., May, 1906,) report a case where death is supposed to have resulted from a too rapid relief of the disease under Roentgen treatment. A total of 8½ hours was given in a period of 54 days. There was a rapid disappearance of the growths and death is presumed to have followed toxæmia from the too rapid absorption of broken-down tissue.

Technique.—Medium or low tube, at 10 inches; exposing 5 minutes over each area, and repeating three times a week.

Auxiliary Treatment.—The leucodescent light will be found a valuable auxiliary.

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NAEVUS.

(Birthmark. Angioma. Strawberry Mark.)

Historical.—The first case was treated by Freund* in 1896. This was a hairy nævus and coincident with the successful treatment of this case was discovered the depilatory properties of the ray.

Pusey† has also been successful in treating hairy nævi.

Jutassy§ reports satisfactory results in a vascular nævus.

Author's Technique.—Low or medium tube, at a distance of 4 to 10 inches, according to the vacuum of the tube. A 10-minute treatment every other day to the production of an acute dermatitis, when treatments are suspended.

*Text-book, p. 230 and Wiener Med. Woehenschrift, 1897, XLVII, p. 428.
§Quoted by Pusey, text-book, p. 565.
†Text-book, p. 565.

ONYCHITIS.

(Inflammation of the Matrix of a Nail.)

A case of chronic pyogenic onychitis which had resisted all forms of local and general treatment, was cured by Pfahler|| with the X-ray. Twenty-five treatments were given covering a period of three months. Improvement appeared after two weeks.

Technique.—A low tube was used at a distance of 6 inches; exposures being 5 minutes in length and repeated three times a week.

PAIN.

The property of the X-ray to relieve pain has been noted in many instances. Among those conditions where it has given the best results are neuralgias, rheumatism, malignant diseases and in gall-stones.

One of the earliest observations was that in taking a skiagraph for the diagnosis of gall-stones, the pain was frequently relieved.

Technique.—The application of the X-ray for its analgesic effect alone must be regulated according to the part treated; the vacuum of the tube and the distance being adjusted to meet these requirements. In general a tube is used that is of a higher vacuum

||Jour. Cutan. Dis., Aug., 1905.

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than would be used in treating the same area for other purposes than the relief of pain. In short, a treatment with a tube and intensity such as would be used in taking a skiagraph of the part is what is indicated. A short, but intense exposure.

Ordinarily the skin should be protected by a leather or aluminum filter to avoid local reaction, if a series of treatments is contemplated. This is unnecessary if only one or two treatments are to be given. The duration of the exposure should be from 3 to 5 minutes, occasionally longer.

Where the pain-relieving effect is desired in a disease that is suitable for X-ray treatment from a general therapeutic point of view, as in malignant cases, the technique is that which is regularly employed for that disease.

PRURITUS.

(Itching.)

Historical.—Sjogren and Sederholm* first reported the beneficial effects of the ray in severe cases of pruritus vulvæ.

Pennington† reported especially satisfactory results in pruritus ani.

The relief from itching in eczema and other skin diseases when under X-ray treatment is one of the first symptoms of improvement noticed.

On the other hand, as the ray is crowded to the point of reaction, one of the first evidences of dermatitis is itching.

Technique.—For pruritus vulvæ et ani, five-minute exposures daily, or every other day, with a medium tube at ten inches; maintained until relief is obtained or reaction threatens. Mucous surfaces react quicker than other parts.

Auxiliary Treatment.—High-frequency sparks from a vacuum tube are a valuable adjunct to the ray in these cases.

*Fortschrift a. d. Geb. d. Roentgenstrahlen, 1901. IV. p. 135. Quoted by Kassabian. Text-book, p. 155.
†N. Y. Med. Journ. Feb. 20th, 1904.

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PSORIASIS.

Historical.—The use of the ray in psoriasis was reported by Strater[1] in 1900, Startin[2], Hahn[3] and others in 1901. Some of these were favorable, others noted only temporary improvement.

Pusey[4] reports a case that improved with falling off of scales and decreased redness but which showed a tendency to recurrence. His opinion is that the ray is valuable in clearing up patches but has no power to overcome the tendency to recurrence.

Burdick[5] reports successful results in 36 cases.

My personal experience[6] would indicate that a symptomatic cure may be expected in 70 to 80 per cent of the cases, but relapses are common.

Bulkley[7] in an exhaustive article on psoriasis has this to say of X-rays:

"I have had cases in which, although new eruptions developed elsewhere, the portions which had been treated by the X-rays remained free. As an adjunct to the local treatment of psoriasis, in proper cases, I consider this new measure a most valuable addition to our armamentarium."

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[1]Deutsche Med. Wochenschrift, 1900, XXVI, p. 546.
[2]Lancet, 1901, II, p. 144.
[3]Fortschrift a. d. Geb. d. Roentgenstrahlen, 1901. V, p. 39.
[4]Text-book, p. 366.
[5]Wis. Med. Recorder, July, 1905.
[6]The X-ray and the High-Frequency Current in the Treatment of Eczema and Psoriasis, Amer. Jour. of Dermatology, May, 1907.
[7]The Cause of Psoriasis, with a Study of 500 Cases Observed in Private Practice. Journ. Amer. Med. Assn., Nov. 17, 1906.

Technique.—I use a medium or low tube, adjusting the distance of the tube from the surface under treatment in accordance with the vacuum of the tube. For a medium tube I place it at about ten inches. For a very low tube, I often bring the wall of the tube within three or four inches of the area treated. In this case I always use a seasoned tube.

A 5 to 7-minute treatment is given every other day or three times a week. Improvement usually takes place early, as in eczema.

Hahn recommends the placing of the tube at a considerable distance when treating a large area to make the ray practically equal in its effect. This would call for a relatively higher tube and longer exposures.

Burdick advocates a medium high tube for psoriasis.

Auxiliary Treatment.—The high-frequency current is of great benefit, in fact, nearly as effective as the X-ray. I always follow up the X-ray exposure with a mild spark from the vacuum tube for a period of from 1 to 5 minutes.

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SARCOMA.

(Hard Cancer.)

Historical.—Cases of sarcoma treated by the rays which were favorably influenced but not cured are reported by Ricketts[1], Beck[2], and Allen[3].

Coley[4] reported three symptomatic cures in 10 cases; McMasters[5], five successful cases; Burdick[6], 18 out of 34 cases apparently cured.

Kassabian[7] says all of his cases ended fatally. Pusey[8] found some cases improved, others unaffected save for the relief of pain. Round-celled sarcomata have yielded most readily, according to the various case histories.

In one case of osteo-sarcoma of the right femur I succeeded in arresting the process and producing apparently a symptomatic cure, but within a year the disease reappeared in the left femur and is now under treatment.

Judd[9] believes the ray to be the best treatment in inoperable cases. He has met with many recurrences, but finds them ordinarily as amenable as the primary lesion.

Cohn[10] reports 3 out of 5 cases of lymphatic sarcoma cured.

Pfahler[11] reports 15 symptomatic cures out of 22 cases.

Leonard[12] strongly commends the X-ray as a palliative and post-operative treatment and says it

"must not be used with a timidity borne of ignorance."

Elischer and Engel[13] claim that a rapidly growing vascular sarcoma is more readily influenced that any other form of cancer.

Dr. C. E. Skinner[14] reports a case of a large fibrosarcoma successfully treated by the X-ray. The case is an unusually interesting one and in a personal letter Dr. Skinner states that there has been no recurrence to date (1909). I give herewith an extensive excerpt from his original report of the case:

"The case was brought to me in January, 1902, from New York City, where she had been for some months under the care of Dr. W. B. Coley, whose description of the case up to that time appears on page 767, Vol. XXI, of the 'Twentieth Century Practice of Medicine.' I quote it as follows:

"'M. J. H—, female, aged 34 years, was referred to me by Dr. Maurice H. Richardson, of Boston, on April 19, 1901. The patient had a well-marked family history of malignant disease. She had been operated upon three years before for what was regarded as a fibroid tumor of the uterus; tubes and ovaries also were removed. No microscopical examination was made. Two months previously she had first noticed a hard tumor in the lower part of the abdominal wall in the region of the cicatrix. There was no pain, no discomfort, but rapid increase in size. When the patient came under my care,

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physical examination showed a tumor, the size of a cocoanut, in the lower part of the abdomen, filling up the entire iliac fossa, extending nearly to the umbilicus, and two inches beyond the median line to the left. The tumor was very firmly fixed and seemed to involve the abdominal wall. An incision was made under cocaine and a portion of the growth, which infiltrated all the muscles of the abdominal wall, was removed for microscopical examination, which showed it to be fibro-sarcoma. The erysipelas toxins were used for ten months. During the first two months the growth decreased more than one-half in size, and for a long time thereafter, while there was no decrease, there was no distinct growth. Later on the influence of the toxins seemed to have become lost, and there was a slow but gradual increase in size. In January, 1902, the tumor was growing rapidly, and at this time the abdomen had the appearance of that of a woman seven months pregnant.'

"Three points are established by Dr. Coley's description. First, that a large deeply located abdominal tumor was present, which was inoperable and malignant in the opinions of two of the ablest surgeons in the United States; second, that these opinions as to malignancy were confirmed by microscopical examination of excised portions of the tumor; third, that in spite of thoroughly applied treatment along approved lines, the tumor was rapidly growing and entirely beyond control.

"The measurements of the tumor when I began to apply the X-rays in January, 1902, were 10 inches from side to side, at the level of the anterior superior spines of the ilia, 8 inches vertically in the median line, and about 5 inches anteroposteriorly in the median line. Estimation of the last-mentioned diameter is based, in addition to the gross appearance, upon observations made by Dr. Coley when the last excision for microscopical examination was done in December, 1901, the incision having been carried down to the peritoneum in the median line; I was assisted in the determination of the other two by Dr. C. A. Bevan, of West Haven, who brought the case to me and who has watched it most carefully throughout. The anterior surface of the mass was evenly convex, somewhat more prominent on the right side than on the left, of stony hardness throughout, firmly adherent to the overlying skin and firmly adherent to the os pubis. The patient weighed 128 pounds, was rapidly losing flesh, markedly cachectic, and so weak that the ascent of half a dozen stairs was an herculean task; she complained of sensations of pressure in the abdomen, and disturbance of the intestinal and bladder functions was present. In a word, the general condition was bad and growing rapidly worse. Pain had never been present.

"The X-ray applications were begun January 28, 1902, and were all administered by means of a tube

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giving rays of high penetration and backing up a spark of from four to six inches, excited by a Morton-Wimshurst-Holtz influence machine having twelve thirty-two inch revolving plates, for the first seven months, and by a machine of the same type having sixteen revolving plates thirty-two inches in diameter for the rest of the time. The anode was placed nine inches from the patient's skin and the duration of the application was 15 minutes; the tube was focused upon the middle of the anterior surface of the tumor at one seance, upon one side at the next, upon the other side at the next, and so on, treating these different areas successively. That the rays penetrated clear through the growth was demonstrated by the fluoroscope when the treatments were applied to the sides of the tumor, the rays being visible in considerable volume upon the opposite side. One layer of thin toweling only was interposed between the source of the rays and the patient's skin, and the face, chest, and the thighs below the level of the pubis were shielded by the tinfoil gauge No. 22. * * *

"To make a long story short, she received forty-six applications up to June 5, 1902, a period of 125 days, being an average of 1 radiation every 2.7 days, when the following condition obtained: The antero-posterior diameter had increased to such an extent that the distance between the anterior superior iliac spines, measured over the tumor, was 15 inches with

the patient lying flat on her back, instead of 13¾ inches, which it had been when treatment was commenced. The vertical dimension of the tumor had increased on the right side but had decreased on the left side to the extent of about an inch, so that the growth was now irregular in outline, its longest axis running diagonally from the upper right hand border about the level of the gall-bladder, to a point just to the left of the os pubis. Three or four times since treatment was commenced she had suffered from attacks of sharp prostration accompanied by febrile movement and circulatory acceleration, which had lasted for from three to seven days. The last one, which was more severe and of longer duration than the others, having occurred in May. These attacks were probably toxæmic in nature. Aside from these attacks her general condition was very good, she was eating well, sleeping well, constantly gaining in strength, and could walk moderately long distances without difficulty. If it had not been for this improvement in the general condition I think I should have discontinued the treatment at this time as the increase in the size of the tumor did not tend to reassure me as to the ultimate outcome.

"On June 7th I sent her to her home in Massachusetts for a 10 days' vacation and when she returned a marked change had taken place. All traces of the toxæmia which were present when she went away had disappeared, she walked with the spright-

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ly step of health, there was a good color in her face, and she reported herself as feeling better than for many months. The most striking change, however, was in the tumor; it seemed to have decreased in size about 20 per cent and the patient had found it necessary to shorten her waist bands and the fronts of her skirts to keep them from dragging on the ground. We resumed the treatment with new courage and considerable hope.

From June 17th to September 3rd, 1902, a period of 78 days, she received 31 radiations, an average of 1 every 2.5 days. Her general health continued good, and the tumor slowly but steadily lessened in size. It was decided in August that she should resume her position (teaching), returning to the sanitarium every week or two for further treatment.

"This line of management was followed out until April 25, 1903, a period of 234 days, during which she received 46 radiations, or an average of practically one every 5 days. On several occasions during this period when she was able to stay but a day, she received two treatments in 24 hours. Slight erythema was induced several times, which always subsided kindly before the time of her next visit; the skin and subcutaneous tissue had assumed a brawny, leathery consistence, and slight evidences of toxæmia of two or three days' duration, but not severe enough to interfere with her daily duties, had appeared three or four times; the tumor had continued to decrease in size, the process of diminution being particularly rapid for several days following each toxæmic attack.

"From April 25th to August 29th, 1903, a period of 127 days, she received 8 treatments, an average of 1 every 15.8 days. Following the application on April 25th, she suffered for 6 days from a sharp attack of toxæmia accompanied by slight soreness of the growth, which was followed by a marked lessening in size. Her weight at that time (August 29, 1903) was 139 pounds, and the tumor was no longer noticeable when she was clothed.

"Early in September, 1903, she developed an area of necrosis as large as a silver half-dollar, two inches to the right of the median line and just above the upper border of the pubis, which was accompanied by very severe pain for two weeks and by fairly constant, but gradually subsiding, pain for 6 weeks more; the ulcer required over three months for complete healing and presented a variation in appearance from the ordinary X-ray ulcer in that no white gangrene was present at any time. It appeared first as a dark-colored scab projecting slightly above the surface of the skin; later pus formed under this scab. When the scab was removed and the cavity washed out the same condition would recur after a few hours. The cavity was about one-quarter of an inch deep with abrupt edges.

"She received her next radiation on November 25,

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1903, although the ulcer was not yet healed. The tumor had diminished rapidly while the burn was in process of evolution, although no radiation had been given, and presented at this time the appearance of a disc-like mass about three inches in diameter and an inch in thickness, lying to the right of the median line and just above the pubis, from which it had now become detached. It was not sensitive to manipulation. The skin over the whole abdomen was mottled dusky red and brawny in consistence; the latter characteristic seemed to extend for some distance into the subcutaneous tissue.

"From this time until May 20, 1904, a period of 185 days, 5 radiations were given, being an average of 1 every 37 days. The patient's weight had increased to 147 pounds, and the tumor had entirely disappeared.

Prognosis.—The statistics at hand would show that the percentage of symptomatic cures in sarcoma is much lower than in carcinoma and I would place it at from 6 to 10 per cent according to variety, etc.*

Technique.—In general the technique is the same as in carcinoma (q. v.), the tube-distance and vacuum being regulated according to the area involved by the disease.

I prefer a soft to medium tube, at 4 to 8 inches for superficial lesions, and a medium to hard tube at

*See footnote under Carcinoma.

8 to 15 inches for deeper tumors. Expose for 10 to 15 minutes three times a week.

Freund prefers a high tube for all cases of sarcoma.

In deep lesions use a leather or aluminum filter, or wet towel to keep the weaker rays from affecting the skin too much before sufficient reaction is obtained on the growth itself.

Phahler[11] advises daily treatment of 20 to 50 minutes with tube at 12 inches, vacuum 6 to 8 Benoist. He keeps up the treatment until irritation is produced, using his sole-leather filter to protect the skin.

X-Ray vs. Operation.—What I have said under the head of carcinoma applies equally well to sarcoma. In nearly all cases operation should precede X-ray exposures, but in selected cases the ray should be given a careful trial first, and in all cases it should follow operation.

The following I quote from an article by Dr. W. W. Babcock*: "Differing from other malignant tumors, sarcomas are usually fairly well encapsulated. This encapsulation becomes more marked after X-ray treatment. The Roentgen rays have a marked destructive action upon the sarcoma cells, yet if the tumor be very large this action is often not sufficient to arrest the disease. Moreover, the degenerative tendency present in all massive malig-

*Therapeutic Gazette, Sept. 15, 1907, p. 608.

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nant neoplasms is enhanced by the rays and the patient's life falls in jeopardy, it may be, not from the growth of the sarcoma cells, but from their death and the absorption of toxic products from the sloughing mass. These patients neither bear severe mutilating operations well, nor are they assured against recurrence by even the most extensive operation that has yet been hazarded by the surgeon. The X-ray treatment alone is insufficient, and surgical intervention alone is likewise insufficient, yet we are impressed by the thought that the combination of the two methods offers the best chance to the patient. Certain conditions are absolutely required, however, in order to obtain the best results. First, the X-ray treatment must be given by an expert over a very prolonged period of time. It may be that daily treatments with a carefully regulated dosage will be necessary for three or four months before any results are perceptible. Thus there is required first of all not a little faith and persistence on the part of the patient. The second point is the necessity for surgical enucleation of all masses as soon as they become a peril to the patient from necrosis or from mechanical pressure. The operation should be of the simplest character, local anesthesia being often all that is required. The overlying tissue and capsule of the tumor are incised, and with the finger or blunt separator the contents of the sac are rapidly enucleated, the sac wiped clean and dry and

painted with a strong alcoholic solution of methylene blue. After the operation the X-ray treatment is at once resumed. If other tumor masses develop under the treatment these are likewise subjected to subcapsular enucleation."

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[1]Journ. Amer. Med. Assoc., 1900, XXXIV, p. 76.
[2]N. Y. Med. Journal, 1901, LXXIV, p. 906.
[3]Boston Med. & Surg. Journal, 1902, p. 431.
[4]American Med., 1902, IV, p. 251. Later in Annals of Surgery, Aug., 1905, he reports only 5 out of 68 cases in which the growth disappeared.
[5]Canada Lancet, Feb., 1903.
[6]Trans. Amer. Roentgen Ray Society, 1905.
[7]Text-book, p. 477.
[8]Text-book, p. 518 et seq.
9. Judd. The X-ray vs. Surgery in Sarcoma. Medical Record, Dec. 29, 1906.
10. Berliner Klin. Woch. XLIII, No. 1, 1906.
11. Therapeutic Gazette, 1908, p. 464, and N. Y. Med. Jour., Dec. 21, 1907. Also Babcock and Pfahler, Surgery, Gyn. and Obs., Feb. 1908.
12. Therapeutic Gazette, Aug. 1908.
13. Deutsche Med. Woch., XXVIII, No. 13, 1907.
14. Archives of Electrology & Radiology, Oct. 1904.

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SYCOSIS.

(Tinea Sycosis. Barber's Itch.)

Historical.—The primary application of the X-ray in sycosis was reported by Freund.*

Many other operators† have also demonstrated its efficiency both in the non-parasitic and in the parasitic forms.

Technique.—With a medium tube at 10 inches, give exposures lasting 7 to 10 minutes each, three times a week. By protecting the surrounding parts carefully the treatment may be crowded a little until the hair falls, or until a good reaction is obtained. It is necessary often to produce this result in order to effect a cure.

Remarks.—Ninety per cent of the cases are curable, though relapses are not unusual. The latter yield readily to additional treatments.

Auxiliary Treatment.—A sharp, high-frequency spark, from a vacuum tube, applied for 30 to 60 seconds after each X-ray exposure will hasten the cure.

*Wiener Med. Wochenschrift, 1897, No. 19. Wiener dermatol. Gesellschaft, May 10, 1899. See Freund's Text-book, p. 227 & 266.

†Hahn, Deutsche Med. Woch., 1901, XXVII, p. 29.
Rinehart, Phil. Med. Jour. 1902. IX, p. 221.
Zechmeister, Monat. f. prakt. Dermat., 1901, XXXII, p. 329.
Pusey Text-book.

TRACHOMA.

(Contagious Granular Conjunctivitis.)

In 1902 and 1903 several cases of trachoma were referred to me by Dr. G. F. Suker, which I treated with the ray with uniformly satisfactory results. Later in my clinic at the Post-Graduate Hospital a number of other cases were treated; part of the time using the high-frequency current in conjunction with the ray.

Newcomet and Krell* and W. F. Coleman† have reported equally satisfactory results.

The first case reported was one presented by Mayou before the London Ophthalmological Society. Coleman reported a case to the Chicago Electrical Society, Jan. 3rd, 1903.

Technique.—In my earlier cases I inverted the eye-lids and with a low tube at 4 to 8 inches distance exposed the lids for two or three minutes, three times a week.

I later found that just as good results followed when the lids were not inverted and I increased the length of treatment to 5 and frequently to 10 minutes, the eyes remaining open. A medium tube when used at 10 inches.

Contrary to what one would at first suppose, the eyes do not seem ordinarily very sensitive to the ray, and stand a comparatively long exposure.

*N. Y. & Phil. Med. Jour., Feb. 4, 1904.

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When we stop to think how many minutes of daily exposure the eyes of operators formerly received, while making fluoroscopic examinations, the length of exposure required in trachoma is really comparatively short. I know by personal experience that when the eyes have been exposed too long, the first symptoms are those of a mild conjunctivitis, the eyes being very watery and sensitive to the light. Stopping of exposures will cause this to subside in a few days.

Newcomet* advises pushing the ray to the extent of a mild burn.

Auxiliary Treatment.—The high-frequency current has proved essentially as successful as the X-ray. It is given with a mild effleuve, or contact with a vacuum tube; 5 to 10-minute treatment, three to four times a week.

A special tube is made for applying the current to both eyes at the same time. The use of the customary local remedies may be kept up in conjunction and thereby hasten the cure.

*Annals of Ophthal. Oct., 1906.

TUBERCULOSIS.

Therapeutic Value of the X-Ray.—The value of the ray in treating superficial forms of tuberculosis has, I think, been well established.

The tubercle bacillus has proved susceptible in these conditions to the action not only of the X-ray, but also of the Finsen light, the high-frequency current and the intense white light.

In pulmonary tuberculosis the results are usually limited to temporary improvement.

The conclusions deduced from numerous experiments would indicate that the ray is not directly or at least not markedly bactericidal, but produces its results through stimulating the reproductive elements of the bacilli to the point of overgrowth. A decrease in their numbers follows from inability to further reproduce.

The action of the ray on the germs when in the human system is much more marked than on plate cultures, indicating that in addition to the effect on the bacilli, considerable benefit accrues from the stimulation of normal physiological processes which the ray is capable of producing, i. e., increase in anti-bodies.

The literature contains so many favorable reports that it is unnecessary to give references concerning this phase of the question, but there are a considerable number who believe the ray has little or no effect upon tuberculosis, among whom may be men-

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tioned Bergonie and Teissier,[1] Dunham[2] and Zeit.[3]

The following condensation of Bullitt's table[4] is worthy of careful consideration:

TUBERCULOSIS	No. Treated.	Cured.	Improved.	Unimproved.
Of long and flat bones...	71	36%	35%	25%
Of joints	141	38%	37%	25%
Of tendon sheaths.....	27	70%	22%	8%
Of peritoneum	32	40%	25%	35%
Of testicle	21	33%	48%	19%
Of lymphatic glands.....	226	35%	40%	25%
Of skin (lupus).....	616	68%	24%	8%

PULMONARY TUBERCULOSIS.

Reasons for and Against the X-Ray.—Theoretically if the X-ray is capable of exerting a curative action on tuberculosis where it occurs in superficial forms, it should also be able to influence it in pulmonary or other deep-seated varieties.

Unfortunately this has not proved true, although beneficial results have been reported in many cases and cures in a few.

I have seen a case respond so quickly that in six weeks no tubercle bacilli were found in the sputum, although they had been abundant at the start and reappeared in two or three months after the ray had been discontinued.

A sufficient amount of improvement is usually manifested to warrant the use of the ray, in combination with the high-frequency current and ozone inhalations, in all cases where this is possible.

[1]Arch. d'Electricité Medicale, 15, XI & XII, 1898.
[2]Trans. Amer. Roentgen Ray Soc., 1903.
[3]Jour. Amer. Med. Assoc., Vol. XXXVII., p. 1432.
[4]Trans. Amer. Roentgen Ray Soc., Sept., 1904.

It gives the patient a much better chance than depending solely on climate, exercise, special feeding, etc., which latter methods, however, must be kept up at the same time.

The most serious obstacle to this, as in all other deep-seated lesions, has been to introduce a sufficient quantity or volume of rays to produce therapeutic effects without setting up a serious dermatitis on the surface. This, of course, is due to the fact that the skin absorbs the greater number of the rays.

At the present time better results in this form are obtained by means of the high-frequency current than with the X-ray.

We must not forget that a skiagraph will show evidence of tuberculous processes in the apices of the lungs before it is possible to detect them by percussion.

Technique.—Use a comparatively high tube at a distance of 15 to 20 inches. Give a seven-minute treatment three times a week, exposing one time through the chest and the next time through the back.

Five-minute daily treatments are advocated by many operators.

Additional protection to the skin may be obtained by filtering out the weaker rays through leather, aluminum or even a wet towel.

Gibson (Journal Advanced Therapeutics, April,

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1908) gives a remarkable report on the results of the ray in 150 cases of pulmonary tuberculosis. He uses a comparatively low tube; protects the whole body except the lungs and exposes chest and back alternately every other day, for 10 minutes. Ozonized nebula, etc., in conjunction.

Auxiliary Treatment.—High-frequency currents given by auto-condensation; also inhalations from an ozone generator.

Recognized forms of hygienic and medical treatment should not be neglected in any of these cases. The X-ray and kindred forms of treatment simply give additional chances for improvement or recovery and do not conflict with other therapeutic measures.

Geyser* employs a method of increasing the arterial blood in the lungs by bandaging all four of the extremities. His results have been excellent. He uses X-ray, auto-condensation, etc., in conjunction.

TUBERCULOSIS OF GLANDS.

General Action and Results.—Under careful and skillful X-ray treatment the percentage of apparent cures is considerably greater than given in Bullitt's table. I would place it at about 60 per cent in cases treated early in the disease.

The action of the ray upon glandular tissue is largely to replace it with connective tissue, at the same time causing the glands to decrease in size.

*Amer. Medicine, Feb., 1908.

No case should be looked upon as not amenable to the X-ray that has had less than three months' treatment.

When to Treat.—We are confronted by the question of whether the given case should be treated by the X-ray or whether in so doing the patient is being denied a chance that he would have of cure, if immediate operation were resorted to.

The result of surgical interference has been that in a large percentage of cases a second or third operation has been necessary and an examination of the records will show that the patient has fully as good a chance with the X-ray as with surgery. There are, however, other facts for consideration.

If a case is seen at an early stage I believe that the X-ray should always be given a thorough trial before operation is resorted to.

If, however, some glands have broken down and a number of others are involved it is possible immediately to do away by surgical means with a mass that it would take some time to influence with the ray. In this case it would be unwise, to say the least, not to operate at once, but operation should in every case be followed by X-radiation to guard against recurrence by destroying small foci that may have been overlooked in the operation.

It is just as culpable to neglect one as the other.

Technique.—Use a low or medium tube, placed 4 to 6 inches from tube-wall to diseased area. Use shield on tube or lead mask. In latter case expose

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a reasonable margin outside of the lesion, and every three or four treatments omit the lead shield.

Seven-minute exposures three times a week to the production of a mild reaction if necessary. After three or four weeks time may be lengthened to ten minutes.

Boggs* in cervical adenitis also advocates raying the apex of each lung.

Auxiliary Treatment.—High-frequency spark to affected glands two to five minutes after each X-ray exposure is advantageous and vibratory stimulation of adjacent glands to increase drainage may be employed.

TUBERCULOSIS OF KIDNEY.

Bircher (Münch. med. Woch., December 17, 1907, LIV, No. 51) reports two cases treated where surgical removal of the kidney had been advised, but refused.

Technique.—He rayed the area of the kidney 15 minutes daily; with moderately high tube at 8 to 10 inches, keeping up the treatment for a long time. Recovery ensued. He noted a marked and rapid change in urinary findings. The exposures covered three months' time with two weeks' break in the treatment in the first case, in which both kidneys were affected.

In the second case the left kidney was affected and the exposures lasted only five weeks. He did

*Journ. Amer. Med. Assoc., Sept. 15, 1906.

not note any ill effects on the renal epithelium. This case was well three years later.

TUBERCULOUS PERITONITIS.

Technique.—Medium or high tube, at 10 to 20 inches, three seven-minute exposures per week; or ten minutes, if a leather or aluminum shield is used. The high-frequency current through a resonator diaphragm or by auto-condensation is preferable to the X-ray in these cases, or may be used in conjunction.

TUBERCULOSIS OF TESTICLE.

Technique.—Medium tube, 10 inches, three times a week, followed by high-frequency effleuve two to five minutes. Protect other testicle, if not involved, with lead shield.

TUBERCULOSIS OF JOINTS.

Technique.—Medium tube at distance of 8 to 10 inches. Expose 7 to 10 minutes at a time and three times a week.

TUBERCULOSIS OF TENDON SHEATHS.

Technique.—Low or medium tube, 4 to 8 inches, 5 to 7 minutes, three times a week.

TUBERCULOSIS OF LONG AND FLAT BONES.

Technique.—Medium or moderately high tube, 8 to 12 inches, three times a week.

TUBERCULOSIS OF LARYNX.

Technique.—Medium tube, 8 to 10 inches; 5 minute treatment every other day. Cover face with a shield, but leave chest unprotected.

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TUBERCULOSIS OF SKIN.

See Lupus.

VENEREAL WARTS.

Burdick (Wis. Med. Recorder, July, 1905) reports a series of twenty-three successful cases. One is illustrated and represents an enormous mass of condylomata, involving all of the surface surrounding vagina and anus, which he states yielded to ten radiations, without any other treatment whatever.

My experience (with two exceptions) has been limited to cases where I have noticed the disappearance of the growths which happened to be present in cases treated for other conditions.

Small warts are easier removed by other methods, but in large and extensive growths the ray would be desirable.

Technique.—Low or medium tube placed at 6 to 10 inches distance, with 5, 7 or 10 minute exposures, every other day.

Dermatitis not very likely to appear.

CHAPTER II.

Results of X-ray Exposures in Various Diseases Where Insufficient Data Exists for Including in the Previous Chapter.

Arthritis Deformans.—Anders, Daland & Pfahler (J. A. M. A., May 19, 1906) report two cases of arthritis deformans in which reduction of the size of the joints and also decrease in the pain and stiffness followed exposure to the ray. Three treatments a week were given with a medium tube at a distance of 15 inches; each treatment lasting about 15 minutes. Massage and passive movements were used in connection.

Rockwell (Med. Record, April 21, 1906) reports no benefit in a case subjected to twenty-four exposures.

Carbuncle.—Morton (Med. Record, May 30, 1903) reports the successful treatment of a carbuncle. He employed a high tube, at six inches distance. Carbuncle exposed through hole in sheet of lead. Duration of treatment eight minutes. No pain after first exposure. Ruptured spontaneously after third application. Three days between first and second exposures; two between second and third.

Chronic Bronchial Affections.—Schilling (Münch. Med. Woch. LIII, No. 37) used the ray to examine a severe case of bronchial asthma. The patient

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found himself benefited by the fluoroscopic examination and Schilling thereafter exposed a large number of cases of chronic bronchitis and bronchial asthma to the rays.

He estimated the result by the effect on the amount of sputum.

In one case, within three days after the treatment the sputum decreased from 150 c.c. to 80 c.c.

In a man of 62 who had been coughing and expectorating for months, the amount decreased from 170 c.c. to 40 c.c. in 16 days and by the end of the fifth week expectoration had entirely ceased.

He noted improvement in each case treated, the amount of sputum ordinarily decreasing one-half on the day following the exposure.

The patient was given only a single sitting, of from 10 to 20 minutes, the rays being applied from two, three or more directions and focused on the points where the rattling was most pronounced.

I consider a 10-minute treatment, with a medium high tube at 12 to 18 inches, repeated every 5 or 6 days, a more satisfactory technique.

Erythema Multiforme.—W. S. Lain (Jour. A. M. A., May 1, 1909) reports "a rather extreme case of erythema multiforme, involving the fingers, the hands and the arms to the elbows," in which usual local and internal treatment was unavailing. Four ten minute X-ray treatments given in six days, caused it to disappear, but it recurred in same places two weeks later. Three treatments on successive

days caused it again to disappear with no further recurrence.

Hydrocephalus and Rachitis.—Cleaves (Archives of Pediatrics, Feb., 1906) reports a case of hydrocephalus treated by the X-ray in connection with an arc-light bath. The X-ray exposure was of five minutes' duration, the distance being six inches from the target, and given from both sides, (bi-parietal). The improvement was marked; the mental improvement being greater than the physical.

Another case due to rickets improved under radiant light treatment.

Lichen Planus.—I have successfully treated two cases of lichen planus, using a medium tube at 10 inches, and giving a seven-minute treatment every other day, followed by the high frequency spark. Eleven treatments required in one case and about twenty in the other.

Zeissler and others have reported equally satisfactory results.

Neuralgia.—Faber (Hospitalstidende, Copenhagen, XLIX, Nos. 27, 28, 1906), reports case of trigeminal neuralgia of four years' duration cured by ten exposures of 10 minutes each, given during a period of 16 days. The upper half of the face was exposed. Two resections in this case had given but temporary relief.

Haret (Presse Médicale, Paris, XV, No. 21, 1907), reports cure of what he calls "epileptiform facial neuralgia."

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"The patient, a man, had suffered for years from daily recurring attacks of facial neuralgia, not relieved even by morphin. The teeth had been drawn, the trigeminal nerve resected, the Gasserian ganglion removed, and also the superior cervical ganglion of the sympathetic, with a truce of never more than six months after each operation. A number of other cases have been treated in the same way, with improvement or cure in all but one. The best results are obtained when the pains radiate from one or more points to which the radiotherapy can be applied. The exposures are made weekly, using three Holzknecht units. The first exposures generally cause transient exacerbation of the pains.

Neuritis.—Leonard, Gray, and others have reported successful results in neuritis. Comroe (N. Y. Med. Journ., Oct. 13, 1906) "has employed the X-ray in selected cases of neuritis in which the cause had been removed either partially or wholly, and which thereafter resisted all modes of hygienic, therapeutic, dietetic and hydrotherapeutic treatments. Six cases are reported. Comroe insists that: 1. The X-ray should be employed in the treatment of neuritis only after all other judicious methods of therapy have failed. 2. The exposure should be directed over as wide an area as may be safe, and frequently repeated in the beginning. 3. The strength of the current and the duration of the exposures should, as a rule, be in direct ratio to the approximate distance of the affected nerve structures from the cutaneous surface overlying them. Idiosyncrasies must be carefully sought. 4. Relief, if obtained, usually makes its appearance early in the treatment. 5. Obstinate cases should receive 'tonic' treatment with a medium tube for some time after the patient has been apparently cured, so as to further assure permanency."

Paget's Disease.—Hartzel (Journal Cutan. Diseases, July, 1906) reports two cases in which exposures were made lasting ten minutes each, with the target first at ten and afterwards at eight inches from the diseased area. Daily exposures at first. In one case the patch had entirely healed in five weeks, nineteen exposures having been given. Slight recurrences were immediately healed by the ray.

Pernicious Anemia.—Renon and Tixier (Bull. Soc. Med. des Hôp. de Paris, March 15, 1906) used the Roentgen ray in connection with diphtheria antitoxin in a case of pernicious anemia. The antitoxin injection and the X-ray exposure were applied alternately. Both measures started a vigorous myeloid reaction. They believe that the destruction of leucocytes by the ray produces leucoylysins, which stimulate a reaction in the bone-marrow. The blood showed 880,000 red and 2,000 white corpuscles to the field. In three months the reds had increased to 2,403,000 and the whites numbered 4,000.

Enlargement of the Prostate.—Haenisch (Münch. Med. Woch., LIV, No. 14, Abs. J. A. M. A., June 8, 1907) reviews the results obtained by other op-

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erators in prostatic hypertrophy, and also describes his own experience. In his technique the patient is placed in a "partial knee-elbow position, the trunk resting on an adjustable cushioned support, and the arms and elbows on a lower cushion. The Roentgen tube is on an adjustable standard and folding arm, centering the rays in a lead glass speculum fastened in the rectum. By this arrangement the patient reclines comfortably and if he moves cannot be injured, as there is nothing to hit against, while the tube does not become uncentered. The necessity of applying the rays to the bladder at the same time is emphasized by Haenisch, who also confirms the experience of others that the success of treatment is in inverse proportion to the duration of the affection. He does not describe his clinical experience further than to state that it has been very satisfactory. The distance between the anticathode and the entrance to the speculum was always about 27 cm. (11 inches); the exposure was six minutes in length, and was repeated until from six to eight exposures had been given in the course of two or three weeks."

Tansard and Fleig (Annales d. Mal. d. Org. Gén.-Urin., Paris, XXIV, No. 24, 1907) report a case where the gland was reduced until it ceased to interfere with urination. They advise the X-ray in cases that have not yet reached the stage of retention; for young patients, and for patients with retention where prompt measures are required, and

finally in case the bladder is infected or the kidney diseased. They gave thirteen exposures in the case reported, exposing the perineum and using a current of 2 to 5 Holzknecht units.

Rudis-Jicinsky (Practical Therapeutics, Aug., 1909) reports on the treatment of twenty-four cases, with relief in all. Six other cases, three of them having malignant involvement, were failures. He uses a special tube now, but earlier exposed through an opening in a sheet of lead.

The results obtained by using mechanical vibration and high frequency currents are so generally satisfactory that I always employ them in connection with the ray in older men and in younger men in preference to the ray.

Roentgen Treatment in Gynecology.—Albers-Schönberg (Münch. Med. Woch., May 11, 1909) "states that Roentgen treatment is an important aid in various gynecologic affections for those who understand the technique of deep exposures. It is possible with them to put an end to menstruation, to cause the shriveling of myomas and cessation of hemorrhages caused by the myomas and the menses, the arrest of preclimacteric and postclimacteric hemorrhage and the relief of menstrual disturbances at any age, with or without sterilization. He relates his experiences in these various lines, remarking that intramural myomas respond more readily to Roentgen treatment than the subserous and the pedunculated. Very large, old myomas already

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showing calcification resist the rays. He has never witnessed any by-effects during or in consequence of the exposures. The symptoms of the premature menopause were slight, and the appearance of 'hot flashes' announced that the desired result was being attained. Older patients are more amenable to Roentgen treatment than younger women." J. A. M. A., June 26, 1909, p. 2121.

Hett (personal communication), reports successful treatment of uterine myomata. His technique consists of 10-minute exposures, with high tube attached to static machine, distance 10 inches. He treats daily for one week, then skips one or two weeks and repeats. This he considers the vital point of the technique.

Stiff Joints.—Moser (Abstract in J. A. M. A., Mar. 23, 1907) states that marked relief followed the treatment of one case, in which the hip-joint was stiff and painful, presumably from an old osteomyelitis.

Complete mobility was not restored in this case, but the pain was lessened to such an extent that increased use was possible. A high tube was used at a distance of from 6 to 12 inches. Exposures were 5 to 10 minutes in length.

Syphilitic Lesions.—Quadrone and Gramegna (Riforma Medica. Naples, XXI. No. 33; Journ. A. M. A., March 17, 1906, page 842) report experiences with the ray in treating initial syphilitic buboes. They find that the glands react to the ray much

more intensely than in other glandular affections, such as tuberculosis or leukemia.

My personal experience in exposing secondary and tertiary lesions has been that there occurred marked improvement for a short time, followed by complete failure to carry the process to a cure.

This temporary improvement I believe to be solely due to the stimulation of physiological processes and I consider the X-ray a failure as a therapeutic measure in syphilitic lesions.

Syringomyelia.—Beaujard and Lhermitte (Semaine Méd., XXVII, No. 17, 1907) confirm the successful results obtained by other operators. "Raymond, Gramegna, Béclère and others have reported six cases in which Roentgen treatment was applied, and the present article adds four more to the list. The rays are applied to the spine and medulla oblongata, and the syringomyelic phenomena gradually subside. The motor disturbances feel the favorable influence first, the abnormal attitude of the hands is corrected and the patient can use his muscles with practically normal strength, although well-established muscular atrophy is but little influenced. Trophic disturbances in skin and bone are arrested, he asserts, and muscles in incipient atrophy regain their normal strength and aspect. The return of sensibility in the skin, and the chronology of the restoration of the sensation of heat, contact and pain throw light on the nature of the affection. One patient personally observed was a

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young man free from pathologic antecedents until the first symptoms of syringomyelia developed four years before. Treatment was commenced in May, 1906, and the spine was exposed to the Roentgen rays; the dose was 3 Holzknecht units, of 7 to 9 penetrating power, and the tube was 15 cm. (6 inches) from the skin. The exposure was generally repeated once a week, a total of 26 sittings in all. Treatment was suspended from time to time to avoid dermatitis. There was no reaction on the part of the skin at any time beyond slight reddening. The rays were applied at a little distance each side of the median line of the spine, and again on the opposite side of the median line, thus giving the spinal cord a double exposure while the skin received only a single exposure on each side. In 1907 five additional sittings were given to cure the persisting facial hemianesthesia, exposing the larger part of the medulla. The sensory bulbar disturbances vanished by the fourth exposure, with no by-effects except slight alopecia of the part exposed. Study of the sensory disturbances will indicate the exact regions in the spine that require treatment, although the adjacent sound regions should be included. The exposures should be made as uniform as possible by covering with lead the parts that have been or are to be exposed.

Varicose Veins.—McGuire (Med. Record, Sept. 1, 1906) reports two cases of varicosed veins successfully treated by the X-ray.

One case, a woman of 45, had eczema of both legs, complicated with varicosed veins. There was also an ulcer on the right leg which failed to respond to any treatment until the ray was used. An extensive dermatitis was produced, but as it gradually subsided both ulcer and varicosed veins disappeared.

The second patient, a man of 50, had a large number of varicosed veins on right leg which were steadily decreasing under the use of the ray.

The result in these cases is in line with the physiological action of the ray.

Miscellaneous Diseases.—I find in going through the literature that references are made by various authors to the successful treatment of a number of conditions without the accompanying clinical reports and without a specific statement of the technique employed. I give herewith a few of these diseases where successful results have been most frequently referrd to:

Chronic Furunculosis (Crops of boils).

Chronic Circumscribed Neurodermatitis.

Elephantiasis.

Ichthyosis (Fish-skin disease).

Rhinoscleroma (Stony hardness of the skin of the nose).

Lichen ruber.

Unresolved Pneumonia.—Edsall & Pemberton (Amer. Jour. Med. Sciences, Feb., 1907) report excellent results in five cases of unresolved pneu-

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monia. Their use was based on the powerful effect the ray has in accelerating autolytic processes, and they further state: 1. The duration of the condition must have been comparatively short, a few weeks at most, organization of the exudate making a cure improbable. 2. It should be a real lack of resolution and not a continued inflammation of the lung. 3. It is important that it is unresolved pneumonia and not tuberculosis that is being treated. Short exposures (5 minutes) daily or every other day were employed. Distance and character of tube are not stated.

Malignant Bladder Disease.—Gray (American Journ. of Surgery, Oct., 1906) reports treating a case of malignant disease of the bladder through a suprapubic incision, using Piffard's protective tube with the smaller extension attached and with a piece of soft rubber drainage tube over the end of the sleeve. The patient was treated about 4½ months, and the result was entirely successful; 10-minute treatments every other day. The case was treated in 1905 and early in 1906, and in a personal letter in 1908 Dr. Gray reports the patient still well and hearty.

Multiple Papillomata of the Larynx.—Gray (Bull. Univ. Coll. of Med., August, 1907) reports treatment of multiple papillomata of the larynx. From a personal letter from Dr. Gray I quote the following summary of the case: "S. C., age 3, was brought to this city (Richmond, Va.) apparently in a dying condition from suffocation caused by almost complete obstruction of the larynx by benign papillomata. The child was immediately operated upon, a tracheotomy being performed by Dr. Jno. Dunn of this city. The case was referred to me for X-ray treatments on July 6, 1906. After a series of ten treatments, changing sides daily, the child returned home with apparent benefit. No shrinkage had taken place in the several months intervening between the tracheotomy operation and the beginning of X-ray treatments. The child was brought back in June, 1907, the growth having very largely disappeared. Another series of ten exposures was given, and again the child left, to return in November, 1907. Papillomata entirely gone, save a small base of one on the left vocal cord near anterior extremity. After a third series of ten treatments this entirely disappeared and she left for her home December 10, 1907, apparently entirely cured, and has remained so up to the present time. The voice has entirely returned, and save for a little huskiness when she left, is perfectly normal."

The tube used read No. 6 on the Benoist scale, with three-fifths of one milliampere in tube circuit, distance 10 inches, time 10 minutes.

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GLOSSARY

Ampere. The unit of current strength or intensity.
Amphophile. A cell staining with either an acid or basic stain.
Anode. The positive pole. In X-ray tubes the anti-cathode is frequently the working positive, instead of the anode. See chart, page 4.
Anti-bodies. The characteristic constituents of the blood of immune animals.
Atrophy. Wasting or decrease in the size of a part.
Break. Opening the electric circuit.
Cachectic. Having a diseased appearance, especially the particular appearance typical of certain diseases.
Cathode. The negative pole.
Chromatin. The more stainable part of the nucleus of a cell.
Condensers. Layers of lead-foil in the coil, which hold a definite charge of electricity. Also the Leyden jars on a static machine.
Dermatitis. Inflammation of the skin. An X-ray burn. In this sense it is used even when the inflammation extends into the deeper structures beneath the skin.
Dermatoses. Skin diseases.
Desquamation. Peeling off of the skin.
Effleuve. The fine sparks from the glass vacuum electrode of the high frequency current.
Electrolysis. Breaking a substance up into its chemical elements by means of an electric current, as with a needle attached to the negative pole of the galvanic current.
Electrolytic. Depending on or pertaining to electrolysis, as in the electrolytic interrupter, where the action depends on the electrical breaking up or analysis of the dilute sulphuric acid contained therein.
Electromotive force. The power which causes electricity to move. It is measured in volts.
Electron. A moving particle carrying an electric charge.
Eosinophile. A cell readily stained by eosin or other acid stain.
Epilation. Removal of hair, root and all.
Erythema. Redness of the skin, as in the reaction from the ray.
Fluoresce. To shine under the influence of violet, ultra-violet or X-rays.
Fluorescence. The property of certain bodies or substances to shine or emit a gleam when subjected to the action of the X-ray or to violet or ultra-violet rays.
Hemoglobin. The coloring matter of the red blood corpuscles.
Heminaesthesia. Absence of sensation in a lateral half of the body.
Histologic. Pertaining to the minute structure or elements of the tissues.
Hyper-keratoses. Small, hard lumps formed from the horny layer of the skin, appearing on the skin (especially on the hands) of X-ray operators or of individuals subjected to other irritants. Similar lumps often appear on the skin of elderly people.

Hypertrophy. Overgrowth.
Inductance. The phenomena of induction.
Induction. The generation of an electric current in a body by the influence of another electrified body.
Indurated. Hardened.
Intra-mural. Situated within the wall of an organ.
Intumescence. Swelling.
Keratosis. See hyper-keratoses.
Lesion. A diseased area.
Leucolytic. Possessing the property of destroying white blood corpuscles.
Leucolysin. A cell or substance that destroys white corpuscles.
Leucotoxin. A toxin or poison produced by the destruction of leucocytes.
Leucocytes. White blood corpuscles.
Leucopenia. Decrease in the number of white blood corpuscles.
Lymphocytes. Lymph cells—a form of white blood corpuscles.
Make-and-break. The closing and opening of the electric circuit as accomplished by the interrupter on a coil.
Mast cells. Cells in leukemic blood containing deeply staining granules. Stain with basic stains.
Metastasis. Transferring of a disease from one part of the body to another not immediately adjacent.
Myeloid. Resembling marrow.
Neoplasm. A new or abnormal growth, such as a tumor.
Neutrophiles. A cell stainable with neutral stains.
Ohm. The unit of electrical resistance.
Oscillatory. Having a wavy or pulsating motion.
Parenchymatous. Pertaining to the vital or essential part of an organ.
Pathological. Diseased or showing the evidences of disease. Abnormal.
Pedunculated. Possessed of a pedicle or stem.
Penetrometer. An instrument for measuring the penetration of the rays.
Physiological. Natural action of an organ or function. Appearance or condition in a state of health.
Pigmentation. Bronzing of the skin under the action of the ray.
Polycythemia. An excess of red blood corpuscles.
Polynuclear. Having many nuclei.
Reaction. The first visible sign of the ray as shown by redness, pigmentation, itching, etc.
Seasoned tube. A tube that has been used some time. Its walls are coated over with fine particles of metal, shutting out many of the soft rays.
Step-up transformer. See transformer.
Stroma. The frame work or foundation tissue of an organ.
Sub-serous. Situated beneath a serous membrane.
Transformer. An instrument which changes the voltage of a current. If it increases the voltage is is called a "step-up" transformer.
Trophic. Pertaining to growth.
Toxemia. Toxins in the blood. A poisoned state of the blood.
Toxin. An amorphous nitrogenous poison formed by bacteria, both in living tissues and in dead substances.
Volt. The unit of electrical pressure or electro-motive force.

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INDEX

Page

Abortion from X-ray.....102
Absorption of the ray.....105
Acne rosacea 161
Acne vulgaris 169
Actinomycosis 169
Action of ray, 96; on blood, 97; on glands, 99; on kidneys, 99; on ovaries, 100, 102; on testes..... 99
Alopecia areata.....169
Anemia, pernicious 243
Angioma 210
Anode 4
Anti-cathode 4, 21
Apparatus, choice of, 31; management of 152
Arthritis deformans 239
Author's technique.....146
Axis ray 70

Baldness 169
Barber's itch 228
Basedow's disease 189
Belated burns 115
Benoist's penetrometer 80
Birth-marks 210
Bladder disease, malignant...250
Blastomycosis 170
Blondes more susceptible.....118
Boils 249
Bronchial affections 239
Bullitt's table of results.....232
Burns, see dermatitis..... 108, 111, 112

Cancer, 172; does the X-ray produce, 116; hard, 216; of skin 183
Carcinoma 172
Cathode, 4, 21; stream..... 21
Chart of X-ray tube.....4, 20
Choice of apparatus..... 31
Chromoradiometers 80, 82
Chronic bronchitis 239
Classification of diseases suitable for treatment.....155
Coil, description of..... 31
Comparison of Benoist and Walter scales 161
Comparison of surgical and X-ray results in malignant disease 172
Conducting cords 68
Consumption 232
Cooper's protective measures..137
Crookes' tubes 19
Cutaneous cancer 183

Dark-room, substitute for in fluoroscopy 75
Dermatitis, 108, 111; acute, 112; chronic, 114; forms of, 112; frequency of, 116; Geyser's theory, 109; a question of dosage, 111; treatment of 115
Description of coil, 39; of static 32
Developer for plates..... 88
Direct rays 22
Discovery of the ray..... 19
Diseases suitable for treatment 155
Does the X-ray produce cancer? 116

Eczema 181
Effect of ray on young amphibians, 102; on pregnancy.102
Electrolytic interrupter 49
Elephantiasis 249
Enlarged prostate 243
Epilation 193
Epithelioma 183
Erythema multiforme 240
Ether, the 21
Ex-ophthalmic goiter 189

Factors governing exposures..118
Fatty tumors 245
Fibroids 205
Filter for the ray.....126
Fluorescence produced in the human body 121
Fluoroscope, 75; care of, 79; examinations with, 77; regeneration of 79
Fluoroscopic examinations, 77; substitute for dark-room in. 75
Focusing 70

General action of ray..... 96
Generation of the ray..... 19
Geyser's dermatitis theory...109
Glands, tuberculous 234
Glossary 252
Goiter 189
Graves' disease 189
Gynecological uses of ray.....245

INDEX

Page

Hair, superfluous 193
High tubes 65
Hodgkin's disease 197
Holzknecht's chromoradiometer 82
How the ray is produced..... 21
Hydrocephalus 241
Hyperidrosis 192
Hyperkeratoses 114
Hypertrichosis 193
Hypertrophy of prostate.....243

Ichthyosis 240
Indirect rays 22
Inflammation of nail.....211
Instruments for measuring quantity of rays..... 84
Intensity of rays.....105
Interrupters, 43; electrolytic, 49; mechanical, 46; mercurial 43
Introduction 9
Itch, barber's 228
Itching 213

Joints, stiff, 246; tuberculous.234

Keloid 195
Keratosis, senile.....196

Leonard's protective measures.134
Leprosy 195
Leucocythemia 197
Leucotoxin 94
Leukemia 197
Lichen planus.....241
Lichen ruber.....249
Lipoma 205
Low tubes 68
Lumpy jaw 163
Lupus vulgaris 205

Malignant bladder disease....250
Management of apparatus....152
Masks, shields, etc.....124
Mechanical interrupters 46
Mercury-turbine interrupters.. 43
Miscellaneous diseases.....249
Multiple papillomata of larynx.250
Multiple spark-gaps 88
Mycosis fungoides.....208
Myomata 245

Naevus 210
Nature of the ray..... 21
Neuralgia 241
Neuritis 242

Onychitis 211

Page

Operation vs. X-ray 119, 156, 177, 225, 235
Operator, protection of.....127

Paget's disease 245
Pain 211
Papillomata of larynx.....250
Patient, protection of.....124
Penetration gauge..... 81
Penetrometers 80
Pernicious anemia.....243
Personal equation, value of ...145
Pfahler's penetrometer, 131; protective measures.....136
Piffard's protective measures..136
Pimples 201
Pneumonia, unresolved.....240
Polarity of terminals..... 54
Portable coils 40
Positive pole, how to tell..... 54
Post-operative radiation 122
Preface 7
Present position of roentgen therapy 25
Primaries, variable..... 40
Principal rays 70
Profuse sweating 192
Prostate, enlargement of.....243
Protection of patient and operator 122
Protective devices..... 124
Protective tubes..... 130, 136
Pruritus, 213; ani, 213; vulvæ 213
Pseudo-leukemia 197
Psoriasis 214
Pulmonary tuberculosis.....232

Quantity of rays, how measured 84

Rachitis 241
Ray fungus 160
Reaction, visible not always necessary 108
Rectifiers 42
Red-nose 186
Regeneration of fluoroscope ... 79
Rheostat 52
Rheumatic arthritis 239
Rhinoscleroma 186
Ringworm 168
Rodent ulcer..... 178
Roentgen 19, 21

Sarcoma 177
Secondary rays 23
Senile keratosis 196
Shields 124, 126

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INDEX

Page

Short exposures more easily controlled 109
Skiagraphs, 87; time of exposure for, 93; value in dislocations and fractures, 94; in legal practice..... 94
Skiagraphy, principles of..... 88
Skin cancer.....183
Soft tubes..... 68
Spark-gaps 53
Sterility from the ray.....101
Sterilization of criminals.....101
Stiff joints 246
Strawberry mark.....210
Superfluous hair.....193
Surgery vs. X-ray..... .....119, 156, 177, 225, 235
Sweating, profuse.....192
Sycosis 227
Syphilitic lesions 246
Syringomyelia 247

Table of vibrations..... 25
Technique, author's, 151; Burdick's, 148; Kienbock's, 148; Pusey's, 150; Schiff and Freund's 146
Terminals, how to tell positive or negative..... 54
Theories about the ray..... 22
Theory of absorption of ray..105
Time switch..... 60
Tinea sycosis 228
Tinea tonsurans 188
To tell positive pole..... 54
Trachoma 229
Tube, chart of, 4; distance of, 72; how connected, 4, 66; hemispheres of..... 68

Page

Tubes, 65; high and low, 65; shield for, 128; to tell good or bad..... 66
Tuberculosis, 231; of glands, 234; of joints, 237; of kidney, 236; of larynx, 237; of long and flat bones, 237; of lungs, 232; peritoneum, 237; of skin, 205; of tendon sheaths, 237; of testicle....237
Tuberculosis, table of results of treatment in.....232

Ulcer, rodent.....183
Unresolved pneumonia.....249

Valves and rectifiers..... 52
Variable primaries..... 40
Varicose veins.....248
Venereal warts.....238
Vibrations, table of..... 25
Visible reaction not always necessary 109
Von Strumpell's protective measures 133

Walter's penetrometer..... 81
Warts 238
When to treat tuberculous glands 235
When to use the X-ray in cancer 176
William's table of intensity of the rays 105

X-ray plates, 87; tubes.....65
X-ray vs. surgery..... .....119, 156, 177, 225, 235
X-rays and sterility.....100

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